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NE TTS 4C

INSTRUCTION MANUAL

FOR

MODEL TTS 4C

TRANSMISSION TEST SET

SERIAL NO. 158

ISSUE 1

NORTHEAST ELECTRONICS CORPORATION

P.O. BOX 649 – CONCORD, N.H. 03301

...ITED IN USA

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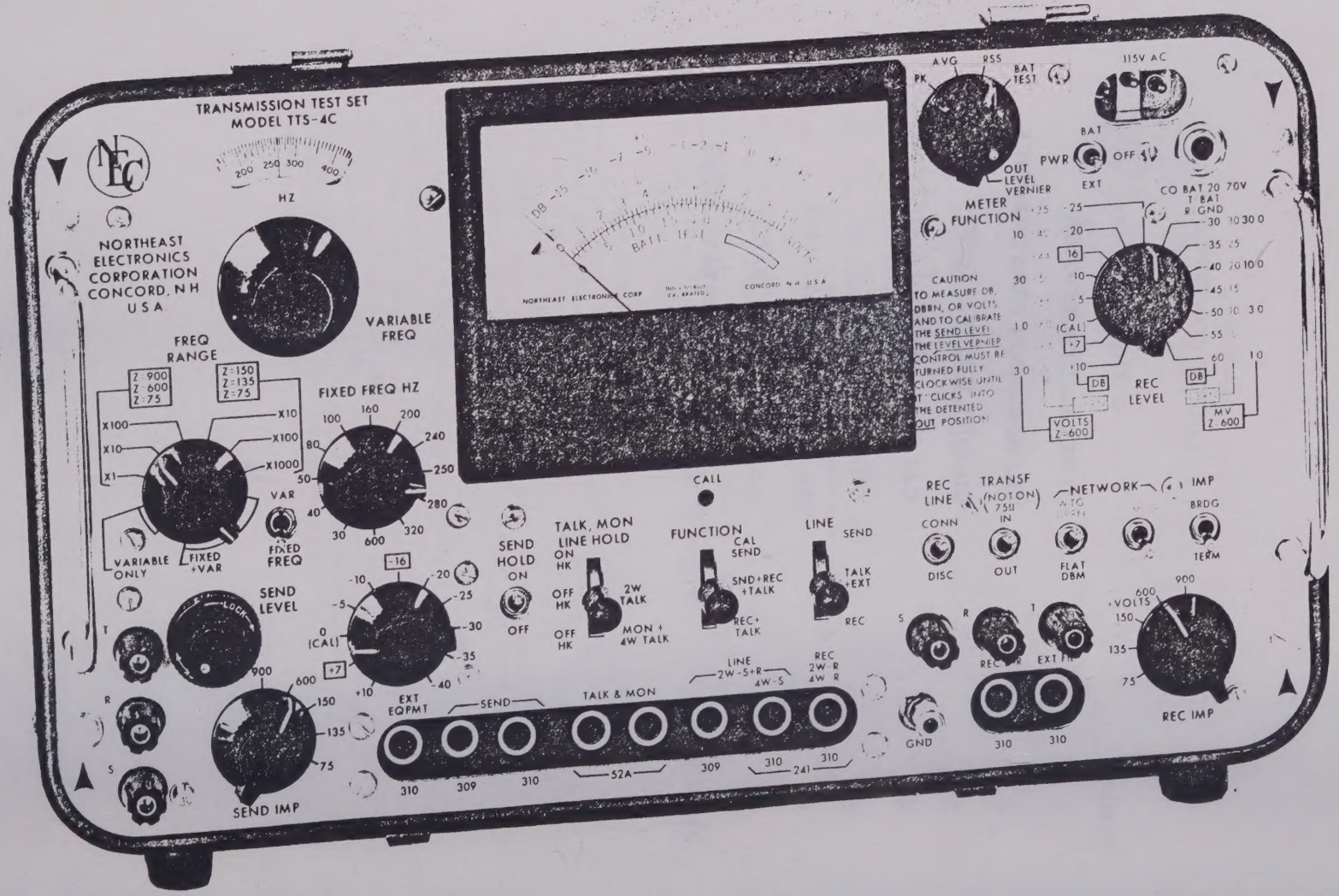
TRANSMISSION TEST SET
MODEL TTS-4C
NORTHEAST ELECTRONICS CORPORATION CONCORD, N H U S A
HZ
VARIABLE FREQ
FREQ RANGE
Z-900 Z-600 Z-75
Z-150 Z-135 Z-75
X100 X10 X1 X10 X100 X1000
VARIABLE ONLY
FIXED +VAR
FIXED FREQ HZ
VAR
FIXED FREQ
SEND LEVEL
LOCK
SEND IMP
EXT EQPMT
SEND HOLD ON OFF
TALK, MON LINE HOLD ON HK OFF HK 2W TALK MON + 4W TALK
CALL
FUNCTION CAL SEND SND+REC +TALK REC+ TALK
LINE SEND TALK +EXT REC
SEND
TALK & MON
LINE 2W-S+R 4W-S
REC 2W-R 4W-R
310 309 310 52A 309 310 241 310
AVG RSS PK BAT TEST
OUT LEVEL VERNIER
115V AC
BAT
PWR OFF EXT
METER FUNCTION
CO BAT 20 70V T BAT R GND
CAUTION TO MEASURE DB, DBRN, OR VOLTS AND TO CALIBRATE THE SEND LEVEL THE LEVEL VERNIER CONTROL MUST BE TURNED FULLY CLOCKWISE UNTIL IT CLICKS INTO THE DETENTED OUT POSITION
REC LEVEL
VOLTS Z-600
MV Z-600
REC LINE CONN DISC
TRANSF (NOTON) 75Ω IN OUT
NETWORK 600Ω 900Ω FLAT DBM
IMP BRDG TERM
REC IMP
GND
310 310

SECTION 1

GENERAL DESCRIPTION

GENERAL

1.1 The Model TTS 4C is a portable transistorized self-contained transmission test set designed to perform transmission, noise and voltage measurements over a wide range of telecommunications circuits ranging from local exchange circuits to 4-wire toll and special service circuits. The set is designed to operate in a frequency range from 30 Hz to 560 kHz.

1.2 The set contains an oscillator, level measuring circuits, filters, precision terminations, impedance matching circuits, talk and monitor circuits, hold coils and switching facilities which are provided to conveniently select the various combinations of features. The set can be operated from internal batteries, from any central office battery from 24 to 70V and from an AC supply.

RECEIVE SECTION

1.3 The level meter in the basic Receive section provides accurate level measurements over a frequency range from 100 to 500,000 Hz; measurements at slightly reduced accuracy can be made over the range of 50 Hz to 1 MHz. The level meter has a maximum sensitivity of -60 dBm at the 0 dBm point on the meter scale and a minimum sensitivity corresponding to +10 dBm for a 0 dBm reading. The scale is calibrated from -15 dBm to +3 dBm. Thus the total range of levels which can be measured extends from -75 dBm to +13 dBm. A weighting network, which incorporates additional gain can be switched in for noise measurements. For this application, the meter scale is also calibrated in dBrn, thereby permitting noise measurements from -5 dBrn to +83 dBrn. In addition, the set provides AC voltage measurements from 100μV to 3.0V. To use the set as a voltmeter, the RECEIVE IMPEDANCE switch must be in the 600Ω position; either the bridging or terminated mode of operation may be used in this case.

1.4 By means of the REC IMP switch, the receive section can be switched for operation on circuits with impedances of 75, 135, 150, 600 and 900Ω and by means of the IMP switch it can be operated either in a high impedance bridging or terminated mode on circuits having these impedances. The input amplifier circuits are balanced to provide suppression of "longitudinal" components for all impedances, except 75Ω. In addition, balanced input transformers can be switched in by means of the TRANSF switch to permit measurements on circuits with high longitudinal voltages. The REC IMP switch automatically connects a low frequency transformer to the TRANSF switch when it is in the 600 or 900Ω position and a high frequency transformer when it is in the 135 or 150Ω position. The receive section is provided with excellent shielding and may be isolated from the LINE and SEND circuits by positioning the REC LINE switch to DISC; in this case, the circuit to be measured is connected to the REC DIR jack or to the REC DIR T-R terminals. The terminal marked S connects to the sleeve of the REC DIR jack. When the REC LINE switch is in the CONN position, the S terminal is extended to the sleeve of the REC 310 jack and the REC DIR T-R terminals are connected to the "disconnect" contacts of this jack and hence to the other circuits in the test set. In addition, a chassis ground terminal marked GND is located in the receive section.

1.5 A 15-position receive attenuator rotary switch, marked REC LEVEL, is provided. It controls the overall sensitivity providing 0 dB meter readings for input levels of +10, +7, 0, -5, -10, -16, -20, -25, -30, -35, -40, -45, -50, -55 and -60dB. The levels of +7 and -16 are provided to facilitate testing of 4-wire circuits;

levels of +5 and -15 dB can be substituted for the +7 and -16 dB levels on special models. A LEVEL VERNIER adjustment, which is controlled by means of the inside concentric control of the METER FUNCTION switch can be switched into the RECEIVE circuit. It permits any level to be read at the 0 dBm position on the meter scale. This feature permits reading level deviations from any pre-determined level. The vernier control is removed from the circuit in the fully CW position of the control. (NOTE: A "click" should be felt.) The detector circuit can be switched by means of the switch marked METER FUNCTION to provide Peak, Average or RSS (quasi-RMS) readings. When measuring a sinusoidal voltage, all three methods of detection will provide the same reading.

1.6 For noise measurements, a weighting network which incorporates an additional 20 dB of gain can be switched in by means of the switch marked NETWORK WTG/ DBRN-FLAT/DBM. This switch selects the flat response when placed in the FLAT-DBM position and a weighting response when placed in the WTG-DBRN position. The switch marked NETWORK C MSG/CCITT selects either the C message network commonly used in the USA or the CCITT weighting network. Other networks or filters can be inserted by using the jack marked EXT FIL.

1.7 The Receive Section may also be used as a voltmeter. In this application, the REC IMP switch must be in the 600Ω position. When the IMP switch is in the BRDG position, the input impedance is approximately 100,000Ω when the TRANSF switch is in the OUT position and about 20,000Ω when it is in the IN position. In addition, a 600Ω termination may be added by moving the IMP switch to the TERM position.

SEND SECTION

1.8 The SEND Section consists of an extremely stable oscillator capable of generating frequencies from 30 Hz to 560 kHz and an output amplifier. Levels of +10 dBm -40 dBm can be supplied to the output circuit through transformers which can switched by means of the SEND IMP sw to match circuits having impedances of 135, 150, 600 and 900Ω.

1.9 A switch marked FREQ-Var/Fixe selects either the continuously variable the fixed frequency operation. The op ating frequency is selected by either th FIXED FREQ rotary switch or the VAR FREQ continuous control in connection the FREQ RANGE switch which is mar X1, X10, X100, X10, X100, X1000. To provide optimum level stability, two ou transformers are used. The transform which is used for the lower frequencie switched in when the SEND IMPEDANC switch is in the 900 and 600Ω position. The high frequency transformer is swi in when the SEND IMPEDANCE switch in the 150 or 135Ω position. No transf is provided on the 75Ω output.

> CAUTION: The 75Ω output is not blocked for DC and must not be connected to circuits carrying DC

The first three frequency ranges, X1, X100, can be used with send impedanc of 900, 600 and 75Ω. The last three fr quency ranges, X10, X100, X1000, ca used with send impedances of 150, 13 75Ω. The last two frequency ranges, X and X1000, can be used only when the FREQ switch is in the VAR position. other frequency ranges can be used wi either fixed or variable frequencies. T prevent erroneous operation and to ale the operator, an interlock circuit inte the power supply to the output amplifi when an improper combination of freq ranges and impedances has been selec

1.10 The send level can be adjusted b means of a vernier control which is p vided with a mechanical locking devic a rotary attenuator switch; these two the designation SEND LEVEL. Unless vernier SEND LEVEL control has bee to provide proper calibration, the lev

markings of the SEND LEVEL attenuator are meaningless. There the SEND level must be calibrated before using the instrument. After the proper calibration procedure has been performed, the 10-position rotary SEND LEVEL attenuator switch provides send levels of +10, +7, 0, -5, -10, -16, -20, -25, -30, -35, and -40 dBm. The levels of +5 and -15 dBm can be substituted for the +7 and -16 dBm levels on special models. The vernier control of the SEND LEVEL also makes it possible to provide any other send level within the attenuator range. This use requires a special calibration procedure.

LINE SECTION

1.11 This group of circuits contains jacks to make connections to the 2-wire and 4-wire LINE circuits under test, TALK and MON jacks to connect a 52A or equivalent headset to the talk circuits in the set, an EXT EQPMT jack to connect external equipment to the circuit under the control of the FUNCTION and TALK MON and LINE HOLD switches and jacks to connect to the SEND circuits directly. Connections to the 2-wire LINE circuit and the SEND circuits may be made through either type 309 or 310 plugs; all other jacks use 310 type plugs.

1.12 The LINE switch is connected to the line jacks. Its function is to select the SEND, REC and TALK + EXT functions. Note that in the REC position it is necessary that the REC LINE switch is in the CONN position; furthermore, the REC IMP switch should be moved to the desired impedance and the IMP switch should be moved to either TERM or BRDG as required for the test to be made. In the SEND position, the desired frequency, impedance and levels should be selected. In the TALK + EXT position of the LINE switch, the line is extended through the EXT EQPMT jack to the built-in talk circuits; to use these functions it is necessary to insert a 52A or equivalent headset into the TALK & MON jacks. External equipment may be connected to the LINE by inserting a cord into the EXT EQPMT jack. This disconnects the talk circuit. In this case, the TALK-MON-LINE-HOLD switch controls a hold coil across the external equipment.

1.13 The TALK-MON-LINE-HOLD switch controls the talk and hold circuits. The hold circuit on the LINE jack is interrupted in the ON HK position of this switch and is connected across the line in the two other positions of this switch, regardless of the position of the FUNCTION or LINE switches. The receiver of the 52A headset is connected to the amplifier detector circuit in the REC section when the switch is in the MON and 4W TALK position and is connected to the talk circuits in the two other positions; the talk circuits are connected to the LINE when the FUNCTION switch is in the TALK and EXT EQPMT position. This permits use of the TALK circuits on both 4-wire and 2-wire circuits. When the switch is in the MON + 4W TALK position, the REC LEVEL control must be adjusted to provide a comfortable receive level.

1.14 The SEND section can be used independently from the rest of the equipment by inserting a plug into the SND 309 or 310 jack. Access to the send circuits can also be obtained on the T+R terminals provided on the front panel. Note however, that the T+R terminals will be connected to the line when the LINE switch is in the SEND position unless a dummy plug has been inserted in one of the two SEND jacks. The S terminal in the SEND section is connected to the sleeves of the SEND, LINE and EXT EQPMT jacks. The SEND HOLD switch controls an additional hold coil which is connected to the SEND circuits when they are used separately as described above.

1.15 The FUNCTION switch in its normal position, marked SND+REC+TALK, extends the control of the SEND, RECEIVE and TALK circuits to the LINE switch. In the CAL SEND position of the FUNCTION switch, it disconnects the send and receive circuits from the line circuits and interconnects them directly to permit calibration of the send level. (It should be noted that to calibrate the SEND signal, the REC

LINE switch should be in the CONN position, the IMP switch in the TERM position and the REC IMP switch on the same impedance as the SEND IMP switch. This is discussed in more detail under the section on calibration.) In the REC+TALK position, the FUNCTION switch disables the oscillator circuit while leaving the other circuits under the control of the LINE switch.

POWER

1.16 The set can be operated from 24 self-contained D cells, from central office batteries having a voltage of 20 to 70V or from an external 110V ac supply. Sets equipped to operate from 220V ac can be supplied on special order. To operate on the internal batteries, the PWR switch is placed in the BAT position; to operate fro central office battery or from ac, the PW switch is placed in the EXT position. The center position of the PWR switch is the OFF position and is so marked. A bracke is provided in the cover of the set to return the PWR switch to the OFF position it should have been inadvertently left in th BAT position when the cover of the set is closed. The condition of the internal batteries can be checked by turning the METER FUNCTION switch to the BAT TEST position. The meter should read within or above the green arc marked BAT TEST.

1.17 Cover

The cover of the set contains a dial, a circuit to measure noise to ground and storage space for cords.

SECTION 2

TRANSMISSION PERFORMANCE

I. SEND SECTION

A. Frequency Range:

1. Variable: Dial marked 50 Hz to 560 Hz

a. Ranges: X1, X10, X100 and X1000. Provides continuous adjustment of frequency from 50 Hz to 560 kHz.

2. Fixed: Switch marked 30, 40, 50, 80, 100, 160, 200, 240, 250, 280, 320 and 600 Hz.

a. Ranges: X1, X10 and X100. Provides fixed frequency settings of 30 Hz to 60 kHz.

B. Frequency Accuracy:

1. Variable: ±5% of dial setting.

2. Fixed: ±2%

C. Frequency Response

1. 75Ω	±0.5 dB	50 Hz	to 560 kHz
2. 135,150Ω	±0.5 dB	5kHz	to 560 kHz
	±0.25 dB	5kHz	to 500 kHz
3. 600,900Ω	±0.5 dB	50kHz	to 50 kHz
	±0.25 dB	100 Hz	to 20 kHz

D. Level Range:

1. Attenuator Steps: +10, +7, 0, -5, -10, -16, -20, -25, -30, -35 and -40 dB.

2. Vernier: +1 dB, -7 dB variable from any of the above steps.

E. Level Accuracy: Calibrated with REC SECTION.

F. Attenuator Accuracy: (1 kHz reference) ±0.15 dB.

G. Total Harmonic Distortion: Less than 1% at any frequency.

H. Output Impedance:

1. 600, 900Ω ±5% 30 Hz to 10 kHz phase angle $<5^{\circ}$

2. 135, 150Ω ±5% 1 kHz to 100 kHz phase angle $<5^{\circ}$
±10% 100 kHz to 560 kHz phase angle $<10^{\circ}$

3. 75Ω ±5% 30 Hz to 560 kHz phase angle $<10^{\circ}$

I. Output Balance:

1. 600, 900Ω 100 Hz >90 dB
3 kHz >70 dB

2. 135, 150Ω 5 kHz >60 dB
560 kHz >30 dB

II. POWER SUPPLY

A. Internal Battery

1. 24 "D" size batteries.

2. Battery Life - approximately 250 hours when discharged 4 hrs/day.

B. Central Office Battery - operates from -20V dc to -70V dc.

C. AC Power - 115V ac 50 to 400 Hz 5 watts

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II. RECEIVE SECTION

A. Accuracy:

1. ±0.1 dB (1000 Hz, 0 dBm 600Ω 25°C ±10°C).

2. ±0.2 dB (1000 Hz, 0 dBm 600Ω 0°C to 50°C).

B. Step Attenuator Error: (Reference to 0 dB)

1. ±0.15 dB/step, maximum accumulated to -55 dB.

2. ±0.2 dB to -60 dB.

C. Meter Tracking

1. ±0.1 dB from 0 dB to ±1.0 dB
from 0 dB to ±2.0 dB
from 0 dB to ±3.0 dB

2. ±0.2 dB from 0 dB to -5.0 dB

3. ±0.5 dB from 0 dB to -10.0 dB

D. Overload Margin:

1. Approximately 5 dB above full-scale meter reading for all ranges.

E. Balanced Bridging Input Impedance (1000 Hz):

100KΩ without transformer
20KΩ with transformer

F. Frequency Response:

1. Rec Imp 135Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level +10 dB to -55 dB

±0.1 dB 100 Hz to 100 kHz
±0.2 dB 100 kHz to 500 kHz
±0.5 dB 50 Hz to 1 MHz
±3.0 dB 20 Hz to 1.5 MHz

2. REC IMP 135Ω
Transformer IN
Meter Function RSS or AVG
Rec Level +10 dB to -55 dB

±0.1 dB 500 Hz to 100 kHz
±0.2 dB 200 Hz to 100 kHz
±0.5 dB 100 Hz to 500 kHz
±3.0 dB 50 Hz to 1.5 MHz

3. Rec Imp 135Ω
Transformer OUT
Meter Function Peak
Rec Level +10 dB to -55 dB

±0.1 dB 500 Hz to 50 kHz
±0.2 dB 300 Hz to 80 kHz
±0.5 dB 200 Hz to 100 kHz
±3.0 dB 20 Hz to 500 kHz

4. Rec Imp 135Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level -60 dB

±0.1 dB 200 Hz to 80 kHz
±0.2 dB 100 Hz to 100 kHz
±0.5 dB 50 Hz to 200 kHz
±3.0 dB 20 Hz to 1 MHz

5. Rec Imp 75Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 500 Hz to 100 kHz
±0.2 dB 200 Hz to 500 kHz
±0.5 dB 100 Hz to 800 kHz
±3.0 dB 20 Hz to 1.5 MHz

6. Rec Imp 150Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 100 Hz to 100 kHz
±0.2 dB 100 kHz to 400 kHz
±0.5 dB 50 Hz to 600 kHz
±3.0 dB 20 Hz to 1.5 MHz

7. Rec Imp 150Ω
Transformer IN
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 500 Hz to 100 kHz
±0.2 dB 200 Hz to 200 kHz
±0.5 dB 100 Hz to 1 MHz
±3.0 dB 50 Hz to 1.5 MHz

8. Rec Imp 600Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 200 Hz to 100 kHz
±0.2 dB 100 Hz to 200 kHz
±0.5 dB 50 Hz to 500 kHz
±3.0 dB 20 Hz to 1 MHz

9. Rec Imp 600Ω
Transformer IN
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 200 Hz to 10 kHz
±0.2 dB 100 Hz to 20 kHz
±0.5 dB 50 Hz to 50 kHz
±3.0 dB 20 Hz to 100 kHz

10. Rec Imp 900Ω
Transformer OUT
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 200 Hz to 100 kHz
±0.2 dB 100 Hz to 500 kHz
±0.5 dB 50 Hz to 800 kHz
±3.0 dB 20 Hz to 1 MHz

11. Rec Imp 900Ω
Transformer IN
Meter Function RSS or AVG
Rec Level 0 dB

±0.1 dB 200 Hz to 10 kHz
±0.2 dB 100 Hz to 20 kHz
±0.5 dB 50 Hz to 50 kHz
±3.0 dB 20 Hz to 100 kHz

G. Input Impedance

1. 75Ω ±5% 1 kHz to 1 MHz
phase angle < 5°

±10% 100 Hz to 1 MHz
phase angle < 20°

2. 135,150Ω ±5% 500 Hz to 50 kHz
phase angle < 5°

±10% 100 Hz to 100 kHz
phase angle < 15°

3. 600,900Ω ±5% 100 Hz to 10 kHz
phase angle < 5°

±10% 100 Hz to 100 kHz
phase angle < 20°

H. Balance (Common mode rejection)

1. 135,150Ω 70 dB 200 Hz to 1 kHz
50 dB 1 kHz to 100 kHz
40 dB 100 kHz to 500 kHz

2. 600,900Ω 90 dB 100 Hz to 1 kHz
40 dB 1 kHz to 100 kHz

I. Weighting Network Frequency Response

Temperature: 25°C

C Message

Reference: 0 dB @ 1kHz
-3 dB from 570 Hz to 750Hz and 2.1 kHz to 2.9 kHz.

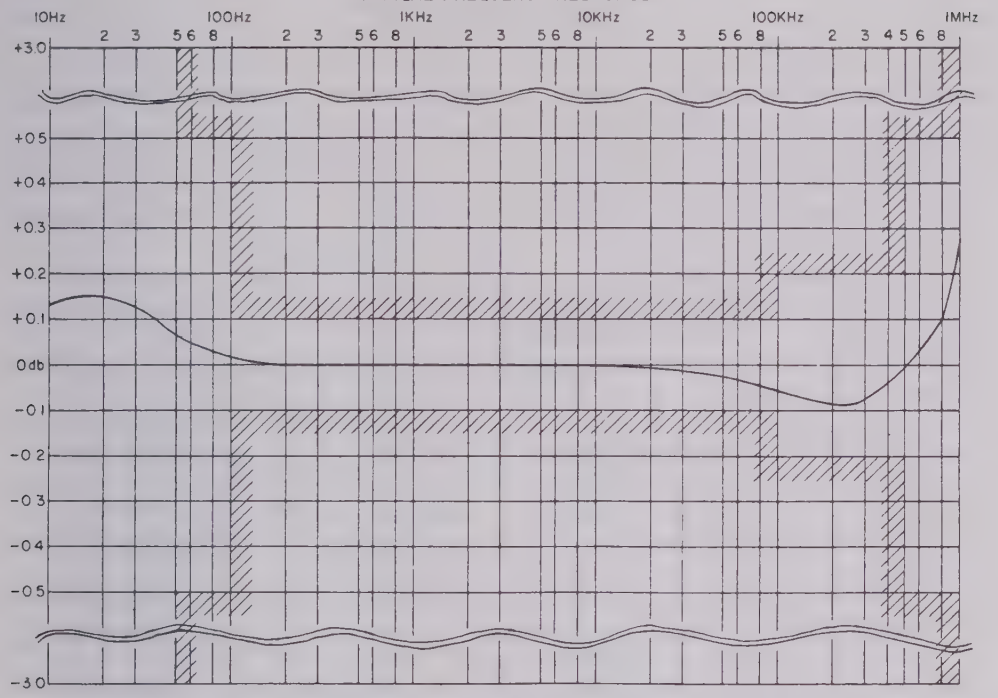
-40 dB from 90 Hz to 150 Hz and 4.8 kHz to 7.2 kHz.

CCITT

Reference: 0 dB @ 800 Hz
-3 dB from 570 Hz to 750 Hz and 2.1 kHz to 2.9 kHz.

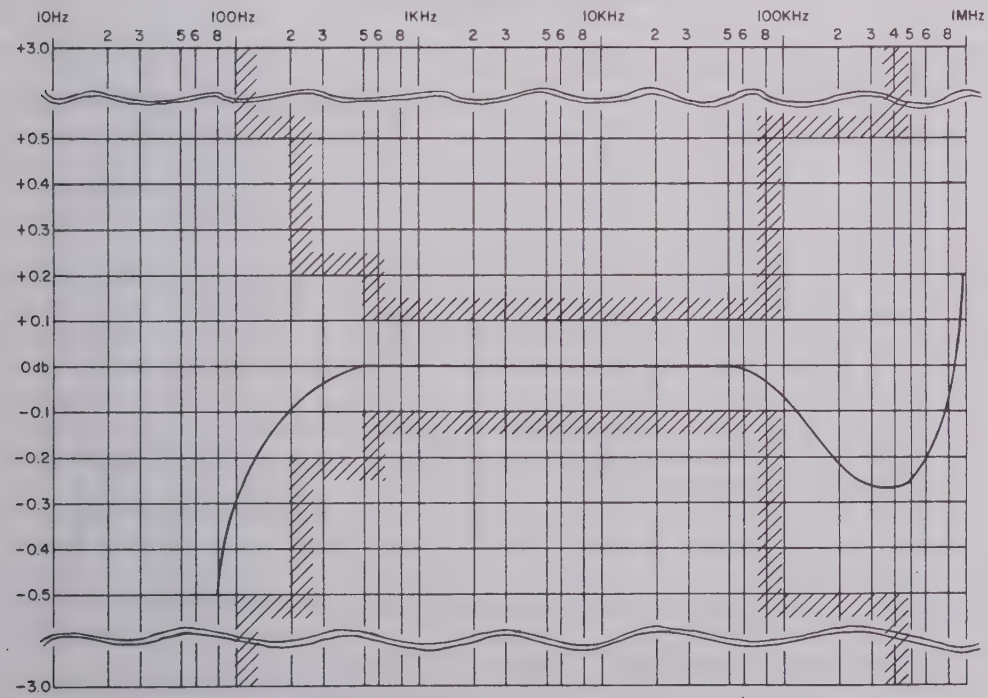
-40 dB from 90 Hz to 150 Hz and 4.8 kHz to 7.2 kHz.

TYPICAL FREQUENCY RESPONSE



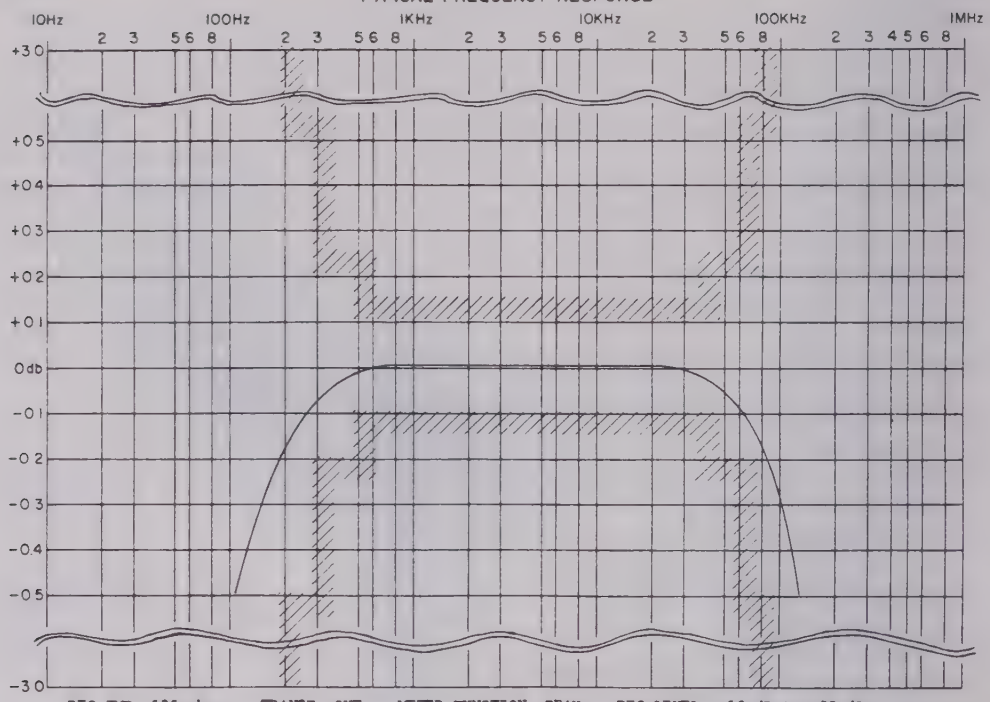
REC IMP 135 ohms TRANSF out METER FUNCTION RSS or AVG REC LEVEL +10 dB to -55 dB

TYPICAL FREQUENCY RESPONSE



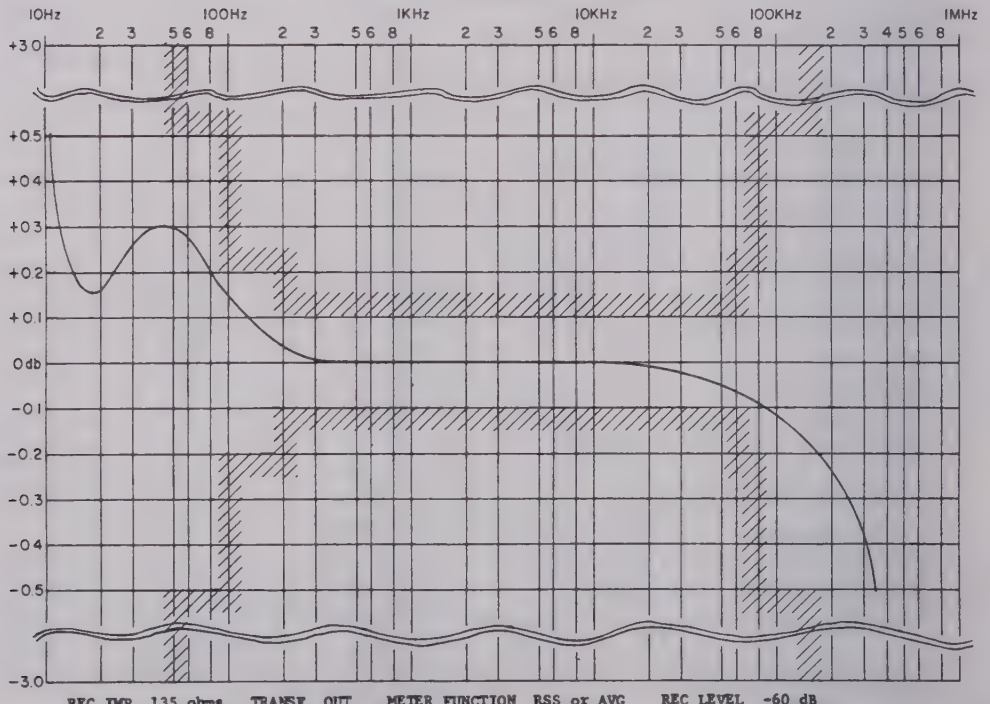
REC IMP 135 ohms TRANSF IN METER FUNCTION RSS or AVG REC LEVEL +10 dB to -55 dB

TYPICAL FREQUENCY RESPONSE



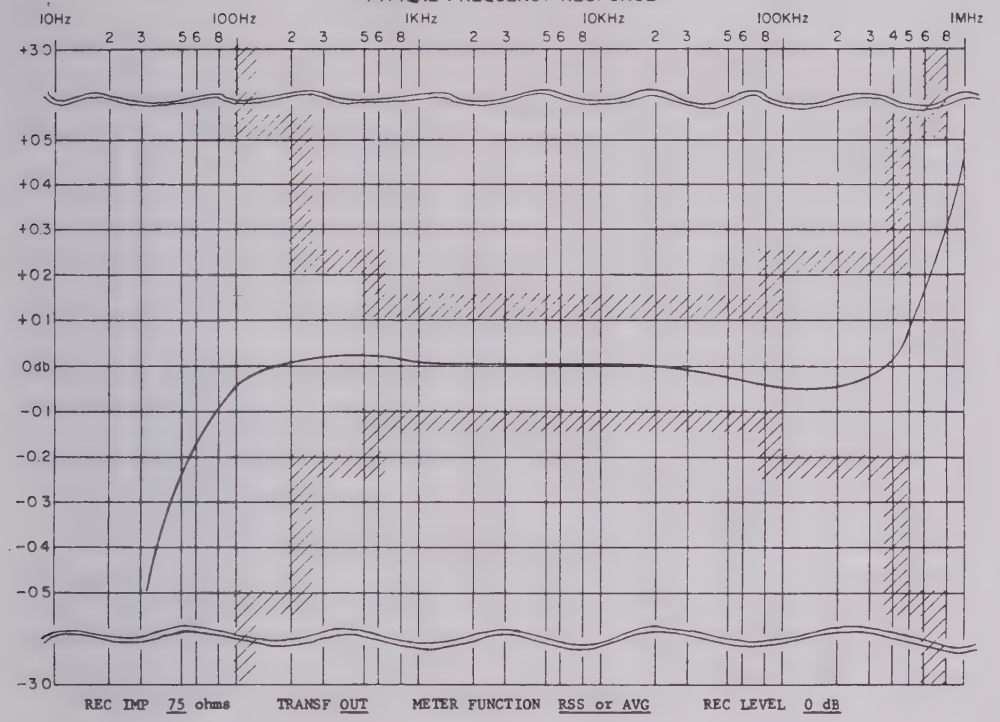
REC IMP 135 ohms TRANSF OUT METER FUNCTION PEAK REC LEVEL +10 dB to -55 dB

TYPICAL FREQUENCY RESPONSE



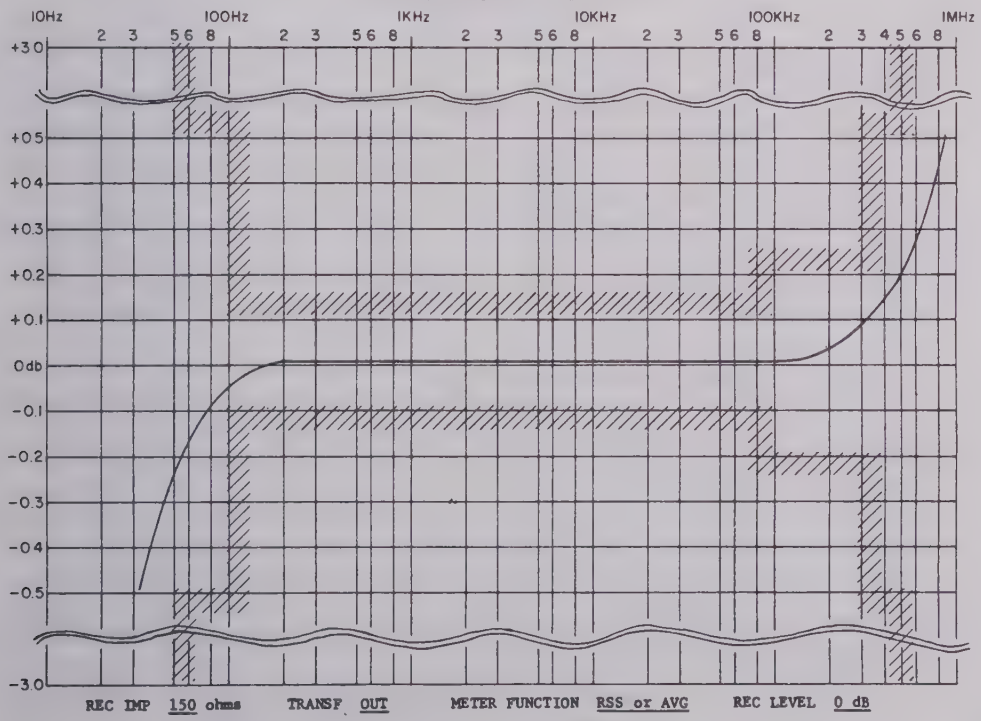
REC IMP 135 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL -60 dB

TYPICAL FREQUENCY RESPONSE



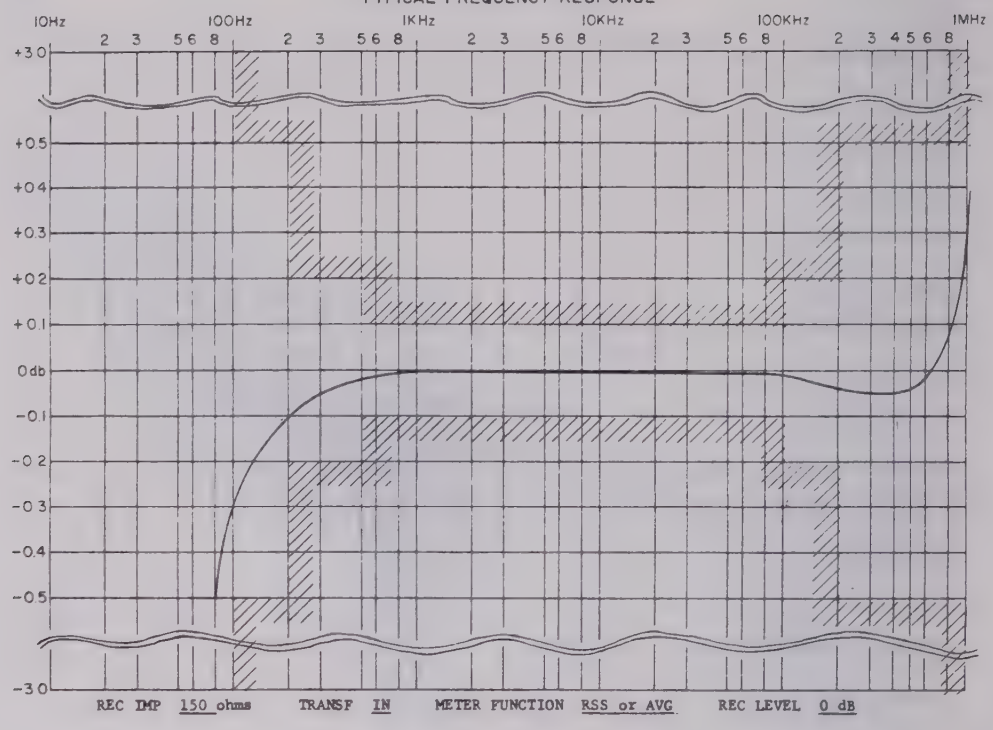
REC IMP 75 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



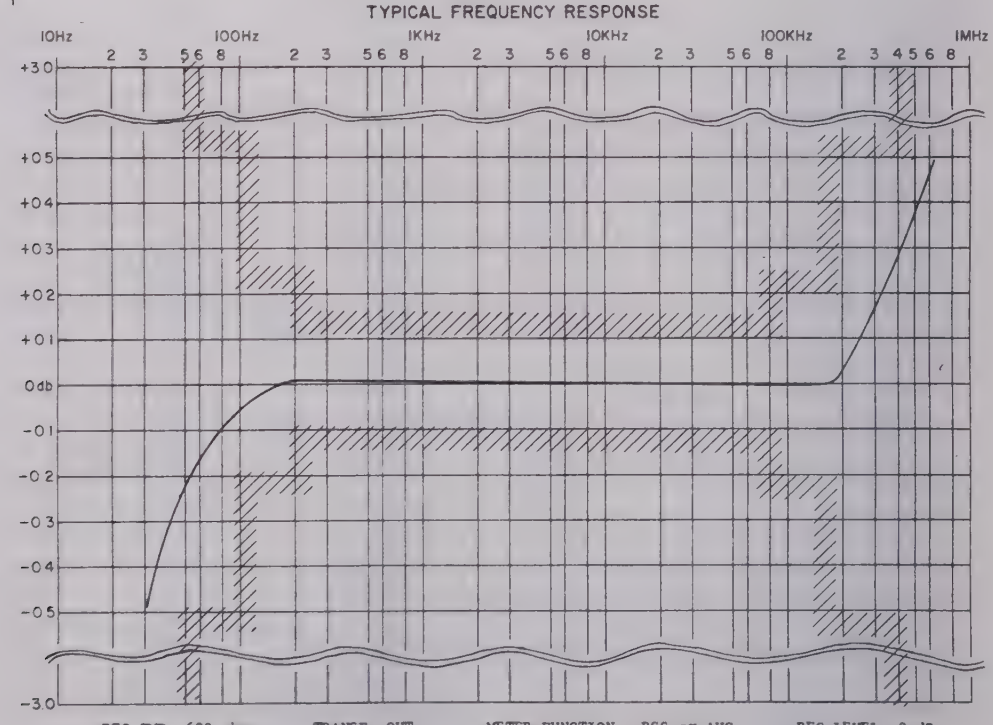
REC IMP 150 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



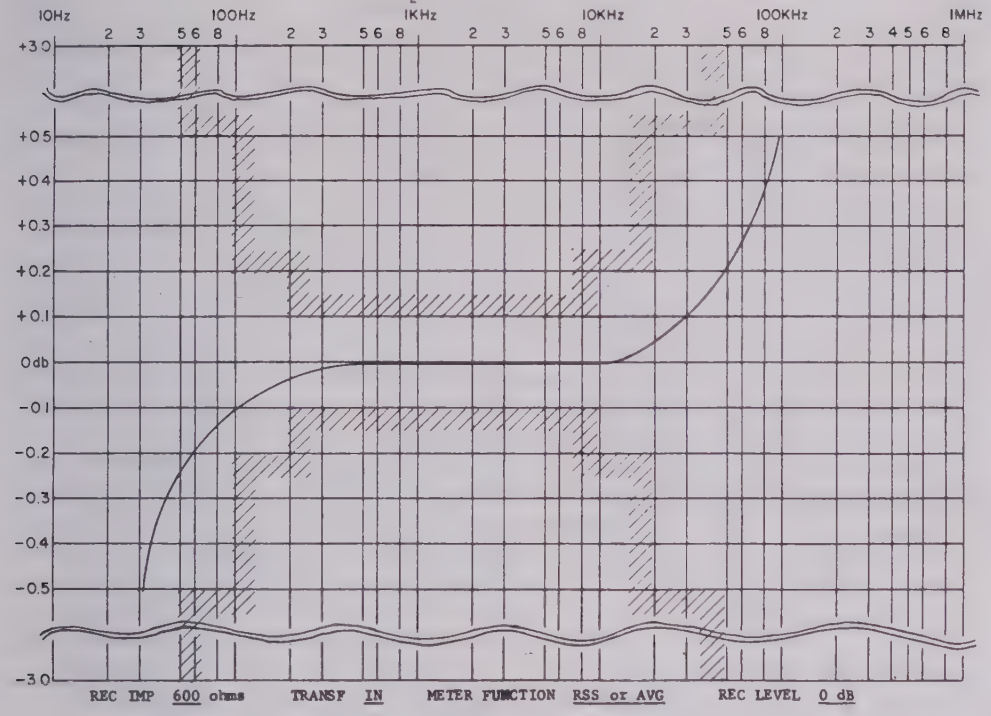
REC IMP 150 ohms TRANSF IN METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



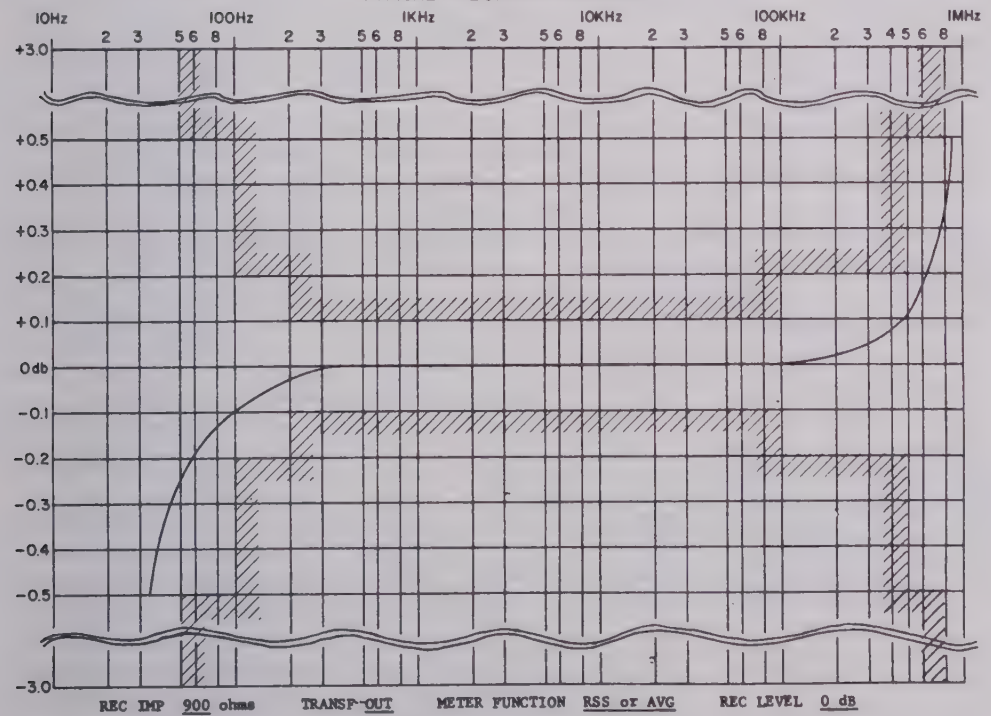
REC IMP 600 ohms TRANSF OUT METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE

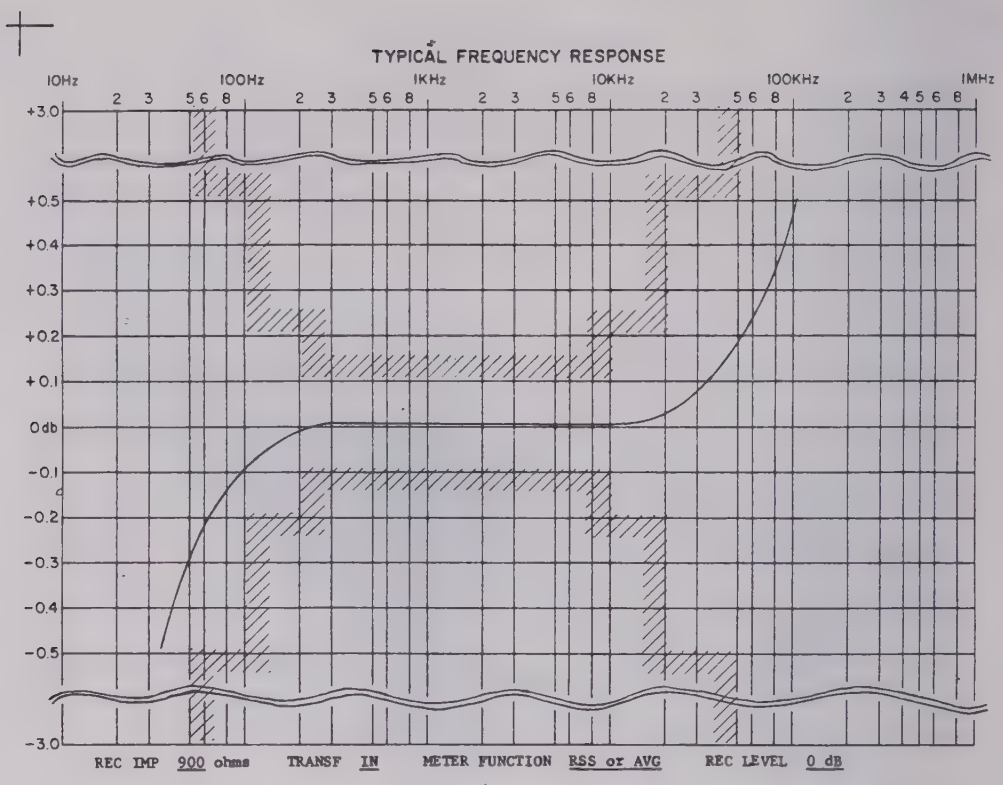


REC IMP 600 ohms TRANSF IN METER FUNCTION RSS or AVG REC LEVEL 0 dB

TYPICAL FREQUENCY RESPONSE



REC IMP 900 ohms TRANSF-OUT METER FUNCTION RSS or AVG REC LEVEL 0 dB


TYPICAL FREQUENCY RESPONSE
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz
2 3 5 6 8
2 3 4 5 6 8
+3.0
+0.5
+0.4
+0.3
+0.2
+0.1
0db
-0.1
-0.2
-0.3
-0.4
-0.5
-3.0
REC IMP 900 ohms TRANSF IN METER FUNCTION RSS or AVG REC LEVEL 0 dB

SECTION 3

CIRCUIT DESCRIPTION

3.1 RECEIVE SECTION

The receive section contains three amplifiers connected in tandem, level controls, impedance selection and termination selection devices and provisions for inserting noise measuring circuits.

The first amplifier is a differential amplifier which provides suppression of longitudinal components for input levels below -10 dBm. For higher levels of these components further suppression can be obtained by inserting an input transformer. A low frequency transformer which operates between 50 and 20,000 Hz is inserted in the 600 and 900Ω positions of the REC IMP switch and a high frequency transformer is inserted in the 135 and 150Ω positions. The high frequency transformer covers 500 to 500,000 Hz. For the controls and their operation, refer to the sections entitled General Description and Operation.

The input amplifier has an input impedance of 100,000Ω and a gain of approximately 10 dB. This gain is varied by the REC IMP switch in such a way as to maintain calibration of the level measuring circuits when they are used on other impedances. The input of the receive section can be switched to provide either BRIDGING or TERMINATED operation. DC blocking is provided in all receive operations. For input levels above -20 dB, starting at -16 dB, a 30 dB fixed attenuator is inserted ahead of the input amplifier under the control of the REC LEVEL switch. The output impedance of this amplifier is less than 10Ω.

The intermediate amplifier provides a gain which can range between 20 and 30 dB, depending on the setting of the REC LEVEL control. The input impedance of this amplifier is approximately 30,000Ω and the output impedance approximately 400Ω. When the NETWORK function is used, its weighted 20 dB amplifier is inserted between the input amplifier and the intermediate amplifier; the same applies to external filters.

The meter amplifier can be switched to provide AVG, RSS or PK (peak) detection.

The average and peak circuits are both conventional. The peak detecting circuit is usable to 100 kHz. In the RSS position, the meter is supplied partially by the AVG and partially by the peak circuits. On a sine wave input, the three different types of detection will provide the same reading. The LEVEL VERNIER control is inserted between the intermediate amplifier and the detector amplifier.

3.2 SEND SECTION

The oscillator uses a conventional Weinbridge circuit equipped with thermistor stabilization. The oscillator circuit drives an output amplifier and it in turn drives the external circuits through transformers. A low frequency transformer is used in the 600 and 900Ω positions and a high frequency transformer is used in the 135 and 150Ω positions. A 75Ω output is available, it does not contain an output transformer and is not blocked for DC. For the controls and their operation, refer to the sections entitled General Description and Operation.

3.3 LINE SECTION

This section contains talk and monitoring circuits, hold coils and switching. The operations of its controls is explained in the General Description and Operation sections.

3.4 POWER SUPPLY

The regulated power supply is of a conventional design; it delivers about 12 volts. When the lid of the set is closed, the PWR switch is automatically returned to the OFF position if it was in the BAT position. This prevents running down the internal batteries.

3.5 COVER

The cover of this set contains a dial, a circuit to measure noise to ground and space for storing of cords and tools.

SECTION 4

CALIBRATION AND MAINTENANCE

4.1 CALIBRATION

If, in the course of routine calibration, it is established that a readjustment of the receive section sensitivity is required, the following instructions should be followed.

CAUTION: MAKE SURE THAT THE EQUIPMENT USED IN CALIBRATING THE TTS 4C IS WORKING PROPERLY BEFORE DECIDING THAT ANY RE-CALIBRATION OF THE TTS 4C SHOULD BE PERFORMED.

1. Place the following controls in the positions as listed:

REC IMP	600
IMP	TERM
REC LINE	DISC
TRANSF	OUT
NETWORK	FLAT DBM
	C MSG
REC LEVEL	0 dB (CAL)

2. Remove the set from the case and leaving the battery connection intact, turn PWR switch to BAT. External power may be used when calibrating set if more convenient. If using internal batteries, place the METER FUNCTION switch to the BAT TEST position to ensure that error will not result from worn-out batteries.

3. Place the FUNCTION switch to the RSS position and connect a 1 kHz, 0 dB (600Ω source) signal to the jack or the T and R binding posts. Note: 0 dB should be calibrated from an accurate source.

CAUTION: The LEVEL VERNIER control must be in the detented (OUT) position, i.e. in the fully clockwise position.

Adjust potentiometer R1021 for ±0.02 dB reading.

4. Place the FUNCTION switch to the AVG position and adjust potentiometer R1030 for +0.02 dB meter reading.

5. Place the FUNCTION switch to the PK position and adjust potentiometer R1015 for +0.2 dB meter reading.

Note: The above steps will allow recalibration for errors of approximately ±0.50 dB. Any error exceeding this would indicate a malfunction in the set and indicates the need for factory repairs.

6. Put a dab of glyptol on the shafts of R1015, R1021 and R1030 to secure them in position.

7. Replace the set in the case.

Note: Calibration at a +0.02 dB reading for a 0.00 dBm input signal is recommended because it splits the error resulting from the approximately 0.05 dB insertion loss of the transformer.

If the set is primarily used with the transformer in, then calibration in this condition may be preferred. Similarly, if the set is primarily used without the input transformer, this may be the preferred calibration method.

4.2 MAINTENANCE

a. Battery Replacement. To replace batteries, remove the screws which hold the lower part of the case and remove it. After installing new batteries, use the BAT TEST switch position to check them before replacing the lower part of the case.

b. Circuit Maintenance. The circuits of the TTS 4 should not require maintenance. If abnormal operation is observed, it is suggested to return the set to the factory.

If field repairs are necessary, the circuit diagrams, which contain the voltage at critical points, will provide sufficien information, when used in combination with the block diagram and the table of levels in the receive and send sections.

SECTION 5

OPERATION

5.1 The GENERAL OPERATING INSTRUCTIONS are contained in Appendix 1 of this manual.

SECTION 6

ELECTRONIC PARTS LIST

6.1 INTRODUCTION. The following pages contain the parts list for the Model TTS 4C Transmission Test Set.

6.2 FSCM Code Numbers. This is the Federal Supply Code of Manufacturers as issued October 1969. A list of codes and their respective manufacturers is given below.

LIST OF MANUFACTURERS

Code No.	
01121	Allen-Bradley, Milwaukee, Wis. 53204
01295	Texas Instruments Inc. Semiconductor Div. Dallas, Texas 75231
03888	Pyrofilm Resistors Co. Inc. Cedar Knoll, N.J. 07927
05397	Union Carbide Corp. N.Y. N. Y. 10017
05844	Callins Industries Inc. Greenfield, Tenn. 38230
06540	Amatom Electronics Hardware Co. Inc. New Rochelle, N. Y. 10801
06819	Northeast Electronics Corp. Concord, N.H. 03301
07716	IRC Division of TRW Inc. New Castle, Del. 19720
09353	C&K Components Inc. Newton, Mass. 02158
12065	Transistron Electronics Corp. E. Boston, Mass. 02128
13606	Sprague Electric Co. Transistor Div. Concord, N.H. 03301
15873	Motorola Inc. Arcade, N.J. 14009
17803	Fairchild Semiconductor Div. Mountain View Cailf. 94041
22650	Whale Electronics Inc. Nashville, Tenn. 37204
24138	International Electronics Corp. Melville, LI, N.Y. 11746
49671	RCA Corp. N.Y. N. Y. 10020
71450	CTS Corp. Elkhart, Ind. 46514
71590	Centralab Milwaukee, Wis. 53201
72982	Erie Technological Products Inc. Erie, Pa. 16512
76854	Oak MFG. Co. Div. of Oak Electro/Netics Corp. Crystal Lake . Ill. 60014
80223	United Transformer Co. N.Y. N. Y. 10013
83330	Smith Herman H. Inc. Brooklyn, N.Y. 11207
84171	ARCO Electronics Inc. Great Neck, N.Y. 11022
84411	TRW Capacitor Div. Ogallala, Neb. 69153
94322	Tel&Labs Inc. Manchester, N.H. 69153

PC Bd. E95319 Oscillator Board

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
C101	C: 100μF 3V	05844	APD 051
C102	C: 50μF 15V	13606	TE 1160
C103	C: 22μF 6V	05397	K22W6K
C104	C: 500μF 3V	05844	APD 101
C105	C: 0.47μF 25V	13606	5C11
C106	C: 68pf 500V	84171	CM15E680J
C107	C: 100μF 3V	05844	APD 051
C108	C: 0.47μF 25V	13606	5C11
C109	C: 100μF 3V	05844	APD 051
C110	C: 0.47μF 25V	13606	5C11
C111	C: 1000μF 12V	05844	9-85PSD
C112	C: 120pf 1Kv NPO	13606	10TCC-T12
C113	C: 8-50pf	72982	539-00234E
C114	C: 100μF 15V	22650	18-375-100-
C115	C: 4.7pf	13606	10TCCV47
R101	R: 3K 5% ¼W	01121	RC07
R102	Pot: 10K	71450	UPE200RE-1
R103	R: 51Ω 5% ¼W	01121	RC07
R104	R: 100Ω 10% ¼W	01121	RC07
R105	R: 18Ω 10% ¼W	01121	RC07
R106	Pot: 100Ω	71450	UPE200RE-1
R107	R: 56K 10% ¼W	01121	RC07
R108	R: 24K 5% ¼W	01121	RC07
R109	R: 9.31K 1% 1/8W	07716	CEATO
R110	R: 120Ω 10% ¼W	01121	RC07
R111	R: 2.2K 10% ¼W	01121	RC07
R112	R: 160Ω 5% ¼W	01121	RC07
R113, R114	R: 68Ω 10% ¼W	01121	RC07
R115	R: 490Ω 1% 1/8W	07716	CEATO
Q101	Transistor FET P Channel	15873	MPF-152
Q102 thru 104	Transistors: PNP	15873	2N3905
Q105	Transistor: NPN	15873	2N3903
CR101 thru 103	Diodes	12065	1N4148
RT101	Thermistor	15801	GB38V2
RT102, 103	Thermistor	15801	KA3IL1

PC Bd. E95335 Frequency Padding Board

C201	C: 8.2pf 1Kv	13606	10TCPV82
C202	C: 1.5-8pf	72982	557091COPO
C203	C: 5-25pf	72982	557091COPO

PC Bd. E95326 Impedance Board

Ref Desig.	Description	Manufacturer (FSCM Code #)	Part Number
01, C302	C: sel val		
03	C: 2.0μF 150V	13606	121P20591R5S4
01	R: 665Ω 1% ½W	07716	CECTO
02	R: 15.8Ω 1% ½W	07716	CECTO
03	R: 665Ω 1% ½W	07716	CECTO
04	R: 2430Ω 1% ½W	07716	CECTO
05	R: 38.3Ω 1% ½W	07716	CECTO
06 and R306A	R: 8.36Ω 1% ½W	07716	CECTO
07	R: 1430Ω 1% ½W	07716	CECTO
08	R: 30.9Ω 1% ½W	07716	CECTO
09	R: 255Ω 1% ½W	07716	CECTO
10	R: 34.8Ω 1% ½W	07716	CECTO
11	R: 27.4Ω 1% ½W	07716	CECTO
12	R: 34.8Ω 1% ½W	07716	CECTO
13	R: 27.4Ω 1% ½W	07716	CECTO
14 and 315	R: 450Ω ¼% 1/10W	94322	CR 16
16, R317	R: 300Ω ¼% 1/10W	94322	CR 16
18, 319	R75Ω 1% ½W	07716	CECTO
20.321	R: 68.1Ω 1% ½W	07716	CECTO

PC Bd. E95327 Output Amplifier Board

401	C: 20μF 15V	13606	TE 1157
402	C: 100μF 12V	22650	16-375-100-12-8PA
403,404	C: 20μF 15V	13606	TE 1157
405	C: 200μF 20V	05844	APD 115
406	C: 830μF 15V	22650	28-750-830-15-8PA
407	C: 68pf	84171	CM15E680J
401,R402	R: 180K 10% ¼W	01121	RC07
403	R: 6.19K 1% 1/8W	07716	CEATO
403A	R: 47K 10% ¼W	01121	RC07
404	R: 1.5K 10% ¼W	01121	RC07
405	R: 620Ω 5% ¼W	01121	RC07
406	R: 1.8K 10% ¼W	01121	RC07
407,R408	R: 10Ω 10% ¼W	01121	RC07
409	R: 75Ω 1% 1/8W	07716	CEATO
410	R: 3.01K 1% 1/8W	07716	CEATO
411	R: 10Ω 10% ¼W	01121	RC07
401	Transistor: NPN	15873	MPS 6515
402,403	Transistor: PNP	15873	2N3905
404	Transistor: NPN	15873	2N3903
R401, CR402	Diodes	12065	1N4148

PC Bd. E95351 Bridge Fixed Cap. Board

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
C501	C: 0.27μF 35V	13606	490P2745R35
C502	C: selected value		
C503	C: 0.027μF 50V 5%	05397	KA2702FK50J
C504	C: selected value		
C505	C: 0.0027μF 50V 5%	05397	KA2701FK50J
C506	C: selected value		
C507	C: 0.27μF 35V	13606	490P2745R35
C508	C: selected value		
C509	C: 0.027μF 50V 5%	05397	KA2702FK50J
C510	C: selected value		
C511	C: 0.0027μF 50V 5%	05397	KA2701FK50J
C512	C: selected value		

PC Bd. E95477 Resistor Padding Board

R601 thru 608	R: sel val	01121	RC07

PC Bd. E95360 30 dB Attenuator and Frequency Adjust

C701	C: 11-110pf trimmer	72982	503-00162F
C702	C: 1.5-8pf trimmer	72982	539-00298A
C703	C: 5pf 1Kv	71590	DD 050
C704	C: 15pf 1Kv	71590	DD 150
R701	Pot: 1K	71450	UPE200RE-1
R702,	R: 390K 10% $\frac{1}{2}$W	01121	RC20
R703	Pot: 500K	71450	UPE200RE-1
R704	R: 2.7K 1% 1/8W	07716	CEATO
R705, 706	R: 390K 10% $\frac{1}{2}$W	01121	RC20

PC Bd. E95273 Balance Amplifier

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
C801	C: 100μF 20V	24138	APD 095
C802, C803	C: 2.2μF 100V NP	22650	51-6838
C804, C805	C: 2.2μF 35V	05397	K2R2W35K
C806	C: 8-50pf trimmer	72982	539-00234E
C807	C: 100μF 20V	24138	APD 095
C808	C: 100μF 20V	24138	APD 095
R806	R: 301Ω1% 1/8W	07716	CEATO
R807	R: 487Ω 1% 1/8W	07717	CEATO
R808	R: 536Ω 1% 1/8W	07716	CEATO
R809	R: 2.94K 1% 1/8W	07716	CEATO
R810	R: 15.8K 1% 1/8W	07716	CEATO
R815	R: 470K 10% ½W	01121	RC20
R816	R: 100Ω 10% ½W	01121	RC20
R817	R: 300K 5% ½W	01121	RC20
R818	R: 510K 5% ½W	01121	RC20
R819, R820	R: 10K 10% ½W	01121	RC20
R821	R: 510Ω 5% ½W	01121	RC20
R822	R: 1K 10% ½W	01121	RC20
R823	R: 909Ω 1% 1/8W	07716	CEATO
R824	R: 300K 5% ½W	01121	RC20
R825	R: 150K 5% ½W	01121	RC20
R826	R: 220K 10% ½W	01121	RC20
R827	R: 9.1K 5% ½W	01121	RC20
R828	R: 4.87K 1% 1/8W	07716	CEATO
R829	R: 6.2K 5% ½W	01121	RC20
R830, R831	R: 6.04K 1% 1/8W	07716	CEATO
R830A	Pot: 5K	71450	UPE 200RE-1
R832	R: 100Ω 10% ½W	01121	RC20
R833	R: 16K 5% ½W	01121	RC20
R834	R: 2.7K 5% ½W	01121	RC20
Q801	Transistors: PNP	15873	2N3905
Q802	Transistors: NPN	15873	2N3903
Q803	Transistors: NPN	15873	2N3903
Q804	Transistors: PNP	15873	2N3905
Q805	Transistors: PNP	15873	2N3905
Q806	Transistors: NPN	15873	2N3903
Q807	Transistors: NPN	15873	2N3903
Q808	Transistors: PNP	15873	2N3905
CR801	Diode	12065	1N4148

PC Bd. E95353 Inter. Atten.

R901	R: 715Ω ½% 1/8W	07716	CEATO
R902	R: 226Ω ½% 1/8W	07716	CEATO
R903	R: 71.5Ω ½% 1/8W	07716	CEATO
R904	R: 33.2Ω ½% 1/8W	07716	CEATO

PC Bd. E95357 Q-RMS Detector

Ref Desig.	Description	Manufacturer (FSCM Code #)	Part Number
C1001	C: 2μF 15V	13606	TE 1149
C1002	C: 0.001μF 1Kv	71590	DD 102
C1003	C: 4.7μF 25V	05397	K4R7W25K
C1004	C: 15μF 10V	05397	K15W10K
C1005, C1006	C: 10μF 20V	13606	150D
C1007, C1008	C: 10μF 15V	13606	TE 1155
C1009	C: 20μF 25V	09353	APD 045
C1010	C: 11-110pf trimmer	72982	557-09134E
C1011	C: 50μF 15V	13606	TE 1160
C1012	C: 10μF 15V	13606	TE 1155
C1013	C: 33pf 1Kv	71590	DD 330
C1014	C: 150pf 1Kv	71590	DD 151
C1015	Sel val		
R1001	R: 330K 10% $\frac{1}{4}$W	01121	RC07
R1002	R: 100K 10% $\frac{1}{2}$W	01121	RC07
R1003, R1004	R: 15K 10% $\frac{1}{4}$W	01121	RC07
R1005	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1006	R: 1K 10% $\frac{1}{4}$W	01121	RC07
R1007	R: 5.6K 10% $\frac{1}{4}$W	01121	RC07
R1008, R1009	R: 1.2K 10% $\frac{1}{4}$W	01121	RC07
R1010	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1011	R: 2.2K 10% $\frac{1}{4}$W	01121	RC07
R1012	R: 12K 10% $\frac{1}{4}$W	01121	RC07
R1013	R: 2.7K 10% $\frac{1}{4}$W	01121	RC07
R1014	R: 12K 10% $\frac{1}{4}$W	01121	RC07
R1015	Pot: 1K	71450	UPE200RE-1
R1016	R: 36K 5% $\frac{1}{4}$W	01121	RC07
R1017	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1018	R: 1K 10% $\frac{1}{4}$W	01121	RC07
R1019	R: 1.3K 1% 1/8W	07716	CEATO
R1020	R: 301Ω 1% 1/8W	07716	CEATO
R1021	R: Pot: 100Ω	71450	UPE200RE-1
R1022	R: 680Ω 10% $\frac{1}{4}$W	01121	RC07
R1023	R: 270Ω 10% $\frac{1}{4}$W	01121	RC07
R1024	R: 1.2K 10% $\frac{1}{4}$W	01121	RC07
R1025	Pot: 100Ω	71450	UPE200RE-1
R1026	R: 82Ω 10% $\frac{1}{4}$W	01121	RC07
R1027	R: 1K 10% $\frac{1}{4}$W	01121	RC07
R1029	R: 1K 10% $\frac{1}{4}$W	01121	RC07
R1030	Pot: 1K	71450	UPE200RE-1
R1031	R: 390Ω 10% $\frac{1}{4}$W	01121	RC07
R1032	R: 1.8K 10% $\frac{1}{4}$W	01121	RC07
R1033	R: 2.0K 1% 1/8W	07716	CEATO
R1034	R: 3.3K 10% $\frac{1}{4}$W	01121	RC07
Q1001	Transistors: NPN	15873	2N3903
Q1002 thru Q1005	Transistors: PNP	15873	2N3905
Q1006 thru Q1009	Transistors: NPN	15873	2N3903
CR1001	Diode	12065	1N4148

PC Bd. E95362 C MSG/CCITT

Ref Desig.	Description	Manufacturer (FSCM Code NO.)	Part Number
R1101	Pot: 10K	07716	500
R1102	R: sel val	01121	RC07
R1103	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1104	R: sel val	01121	RC07
R1105	R: 27K 10% $\frac{1}{4}$W	01121	RC07
R1106	R: 68K 10% $\frac{1}{4}$W	01121	RC07
R1107	R: 3.9K 10% $\frac{1}{4}$W	01121	RC07
R1108	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1109	R: 4.7K 10% $\frac{1}{4}$W	01121	RC07
R1110	R: 56K 10% $\frac{1}{4}$W	01121	RC07
R1111	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1112	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1113	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1114	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1115	R: 470Ω 10% $\frac{1}{4}$W	01121	RC07
R1116	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1117	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1118	R: 56K 10% $\frac{1}{4}$W	01121	RC07
R1119	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1120	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1121	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1122	R: 470Ω 10% $\frac{1}{4}$W	01121	RC07
R1123	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1124	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1125	R: 56K 10% $\frac{1}{4}$W	01121	RC07
R1126	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1127, R1128	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1129	R: 470Ω 10% $\frac{1}{4}$W	01121	RC07
R1130	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1131	R: 10K 10% $\frac{1}{4}$W	01121	RC07
R1132	R: 56K 10% $\frac{1}{4}$W	01121	RC07
R1133	R: 33K 10% $\frac{1}{4}$W	01121	RC07
R1134, R1135	R: 6.8K 10% $\frac{1}{4}$W	01121	RC07
R1136	R: 270Ω 10% $\frac{1}{4}$W	01121	RC07
R1137	R: 100Ω 10% $\frac{1}{4}$W	01121	RC07
R1138	R: 1.5K 10% $\frac{1}{4}$W	01121	RC07
R1139	R: 390Ω 10% $\frac{1}{4}$W	01121	RC07
R1140	R: 1K 10% $\frac{1}{4}$W	01121	RC07
Q1101 - 1106	Transistors: PNP	15873	2N3905
C1101	C: 0.22μF 50V	05397	KR22W50K
C1102	C: 0.1μF 50V	05397	KR1W50K
C1103	C: 0.0056μF 100V	13606	225PW
C1104	C: 1.0μF 35V	05397	K1W35K
C1105	C: 0.015μF 100V	13606	225PW
C1106	C: 22μF 6V	05397	K22W6K
C1107	C: 0.012μF 100V	13606	225PW
C1108	C: 0.056μF 100V	13606	225PW

PC Bd. E95362 C MSG/CCIT (cont)

Ref Desig.	Description	Manufacturer (FSCM Code #)	Part Number
C1109	C: 0.015μF 100V	13606	225PW
C1110	C: 22μF 6V	05397	K22W6K
C1111	C: 0.012μF 100V	13606	225PW
C1112	C: 0.056μF 100V	13606	225PW
C1113	C: 0.015μF 100V	13606	225PW
C1114	C: 22μF 6V	05397	K22W6K
C1115	C: 0.012μF 100V	13606	225PW
C1116	C: 0.056μF 100V	13606	225PW
C1117	C: 0.015μF 100V	13606	225PW
C1118	C: 22μF 6V	05397	K22W6K
C1119	C: 0.012μF 100V	13606	225PW
C1120	C: 100μF 12V	22650	16-375-100-12-8
C1121	C: 2.2μF 35V	05397	K2R2W35K

PC Bd. E95275 Inter. Amplifier

Q1201 thru 1203	Transistors: PNP	15873	2N3905
C1201	C: 4.7μF 25V	05397	K4R7W35K
C1202	not used		
C1203	C: 6.8μF 20V	05397	K6R8W20K
C1204	C: 15μF 10V	05397	K15W10K
C1205	C: 22μF 6V	05397	K22W6K
R1201	R: 2K pot	71450	UPE200RE-1
R1202	R: 150K 5% ½W	01121	RC20
R1203	R: 301Ω 1% 1/8W	07716	CEATO
R1204, 1205	R: 33K 5% ½W	01121	RC20
R1206	R: sel val		
R1207	R: 2.2K 5% ½W	01121	RC20
R1208	R: 390Ω 10% ½W	01121	RC20
R1209	R: 2.2K 5% ½W	01121	RC20
R1210	R: 8.25K 1% 1/8W	07716	CEATO
R1211	not used		
R1212	R: 1K 10% ½W	01121	RC20

PC Bd. E95312 -12V Regulator Board

Q1301 thru 1304	Transistors: PNP	17803	2N4356
CR1301	Diode	01295	1N2069
CR1302	Diode: zener	12065	1N762
C1301	C: 0.1μF 100V	13606	225PW
C1302	C: 250μF 25V		APD 126
C1303, 1304	C: 20μF 25V		APD 046
C1305	C: 15μF 10V	05397	K15W10K
R1301, 1302	R: 33K 5% ½W	01121	RC20
R1303	R: 3.9K 5% ½W	01121	RC20
R1304	R: 15K 5% ½W	01121	RC20
R1305	R: 5K pot	71450	UPE200RE-1
R1306 thru 1308	R: 10K 10% ½W	01121	RC20

PC Bd. E95315 -18V Regulator Board

Q1401	Transistor: NPN	49671	2N3054
Q1402	Transistor: PNP	17803	2N4356
CR1401 thru 1406	Diodes	01295	1N2069
CR1407	Diode: zener	15873	1N967
C1401, 1402	C: 470pf 1Kv	71590	DD 471
C1403	C: 100μF 50V	22650	MD-24-437-100-50
R1401	R: 4.7K 10% ½W	01121	RC20
L1401, 1402	Inductor: 100μh		9350-08
F1401	Fuse: 1/10 amp	75915	3AG-1/10SB

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
	S-1 Frequency Range		
S1	S: rotary 4dk, 8 pole 6 pos shorting	71590	1268-083
R6	R: 6.04 Meg 1%	03888	PME 65TO
R7	R: 619K 1% 1/8W	07716	CEATO
R8	R: 61.9K 1% 1/8W	07716	CEATO
R9	R: 6.19K 1% 1/8W	07716	CEATO
R10	R: 6.04 Meg 1%	03888	PME 65T0
R11	R: 619K 1% 1/8W	07716	CEATO
R12	R: 61.9K 1% 1/8W	07716	CEATO
R13	R: 6.19K 1% 1/8W	07716	CEATO
C9	Sel val		
	S-3 Fixed Frequency		
S3	S: rotary 4 dk, 4 pole, 12 pos positive shorting	71590	1268-084
R14	R: 18.7K 1% 1/8W	07716	CEATO
R15	R: 1.1 Meg 5% $\frac{1}{2}$W	01121	RC 20
R16	R: 13.7K $\frac{1}{2}$% 1/8W	07716	CEATO
R17	R: 11K $\frac{1}{2}$% 1/8W	07716	CEATO
R18	R: 6.81K $\frac{1}{4}$% 1/8W	07716	CEATO
R19	R: 5.49K $\frac{1}{2}$% 1/8W	07716	CEATO
R20	R: 3.48K 1% 1/8W	07716	CEATO
R20A	R: 240K 5% $\frac{1}{2}$W	01121	RC20
R21	R: 2.74K $\frac{1}{2}$% 1/8W	07716	CEATO
R22	R: 2.32K 1% 1/8W	07716	CEATO
R22A	R: 150K 5% $\frac{1}{2}$W	01121	RC20
R23	R: 2.21K 1% 1/8W	07716	CEATO
R23A	R: 330K 10% $\frac{1}{2}$W	01121	RC20
R24	R: 1.96K $\frac{1}{2}$% 1/8W	07716	CEATO
R25	R: 1.71K $\frac{1}{2}$% 1/8W	07716	CEATO
R26	R: 931Ω 1% 1/8W	07716	CEATO
R26A	R: 56K 10% $\frac{1}{2}$W	01121	RC20
R27	R: 18.7K 1% 1/8W	07716	CEATO
R28	R: 1.1 Meg 5% $\frac{1}{2}$W	01121	RC20
R29	R: 13.7K $\frac{1}{2}$% 1/8W	07716	CEATO
R30	R: 11K $\frac{1}{2}$% 1/8W	07716	CEATO
R31	R: 6.81K $\frac{1}{4}$% 1/8W	07716	CEATO
R32	R: 5.49K $\frac{1}{2}$% 1/8W	07716	CEATO
R33	R: 3.48K 1% 1/8W	07716	CEATO
R33A	R: 240K 5% $\frac{1}{2}$W	01121	RC20
R34	R: 2.74K $\frac{1}{2}$% 1/8W	07716	CEATO
R35	R: 2.32K 1% 1/8W	07716	CEATO
R35A	R: 150K 5% $\frac{1}{2}$W	01121	RC20
R36	R: 2.21K 1% 1/8W	07716	CEATO
R36A	R: 330K 10% $\frac{1}{2}$W	01121	RC20
R37	R: 1.96K $\frac{1}{2}$% 1/8W	07716	CEATO
R38	R: 1.71K $\frac{1}{2}$% 1/8W	07716	CEATO
R39	R: 931Ω 1% 1/8W	07716	CEATO
R39A	R: 56K 10% $\frac{1}{2}$W	01121	RC20

S-4 Send Level

S4	S: rotary, 4 dk 4 pole 12 pos positive shorting	71590	1268-084
R40	R: 146Ω ½% 1/8W	07716	CEATO
R41	R: 196Ω ½% 1/8W	07716	CEATO
R42	R: 69.2Ω ½% 1/8W	07716	CEATO
R43	R: 38.9Ω ½% 1/8W	07716	CEATO
R44	R: 49.9Ω ½% 1/8W	07716	CEATO
R45	R: 133.8Ω ½% 1/8W	07716	CEATO
R46	R: 122.5Ω ½% 1/8W	07716	CEATO
R47	R: 133.8Ω ½% 1/8W	07716	CEATO
R48	R: 91.75Ω ½% 1/8W	07716	CEATO
R49	R: 371.3Ω ½% 1/8W	07716	CEATO
R50	R: 91.7Ω ½% 1/8W	07716	CEATO
R51	R: 79.9Ω ½% 1/8W	07716	CEATO
R52	R: 1180Ω ½% 1/8W	07716	CEATO
R53	R: 79.9Ω ½% 1/8W	07716	CEATO

SEND section miscellaneous

C1A, C1B	C: 13.5-452.3pf	84411	25.2A
C2	C: 100μF 150V NP	13606	D 47141
	Spacers: 4-40 1 1/16" hex spacer	06540	8221-B-0440
R1	R: 2.5K pot	71590	B9-856
	¾" hex-standoff Male/female	06540	9741-A-0440
T1	Transformer	80223	A-20
T2	Transformer	06819	4008-01-0808
S2	S: toggle DP/DT	09353	7201
J1	Binding post: red insulated		5595-175-2
J2, J3	Binding post: black insulated		5595-175-0
TP1, TP2	Standoff-insulated		260-1
S5	S: rotary (SEND IMP) 6 dk 12 pole, 5 pos shorting	76854	A-1268-081

LINE section

C3	C: 0.05μF 200V	13606	2TM-S50
C4	C: 2μF 150V	13606	121P20591R5S4
C5	C: 10μF 50V	13606	TVA-1304
R3	R: 20K 5% ½W	01121	RC20
R4	R: 500Ω 5% 3W	13606	242E5015
L1, L2	Hold coils	06819	TN 1274
S6	S: toggle DP/DT	09353	7201
S7	S: key	82389	172N
S8, S9	S: key	82389	173P
J4	J: For 310 type plug	82389	5J-1192
J5	J: For 309 type plug	82389	5J-1490A
J6	J: For 310 type plug	82389	5J-1492
J7, J8	J: For 52A type plug	82389	5J-1194
J9	J: For 309 type plug	82389	5J-1490A
J10, J11	J: For 310 type plug	82389	5J-1492

S-14 REC IMP

Ref Desig.	Description	Manufacturer (FSCM Code No.)	Part Number
S14	S: rotary 5 dk 10 pole, 5 pos shorting	71590	A-1268-082
R54, R55	R: 68.1Ω 1% 1/8W	07716	CEATO
R56, R57	R: 75Ω 1% 1/8W	07716	CEATO
R58, R59	R: 301Ω 1% 1/8W	07716	CEATO
R60, R61	R: 453Ω 1% 1/8W	07716	CEATO
T6	Transformer	06819	4009-010808

S-16 REC LEVEL

S16	S: rotary 6 dk 6 pole 15 pos non-shorting	76854	269130-EK8
R62, R63	R: 48.7K 1% 1/8W	07716	CEATO
R64	R: 3.83K 1% 1/8W	07716	CEATO
R65	R: 6.98K 1% 1/8W	07716	CEATO
R66	R: 3.83K 1% 1/8W	07716	CEATO
R67	R: 11K 1% 1/8W	07716	CEATO
R68	R: 3.83K 1% 1/8W	07716	CEATO
R69	R: 15K 1% 1/8W	07716	CEATO
R70	R: 3.83K 1% 1/8W	07716	CEATO
R71	R: 11K 1% 1/8W	07716	CEATO
R72	R: 3.83K 1% 1/8W	07716	CEATO
R73	R: 11K 1% 1/8W	07716	CEATO
R74	R: 3.83K 1% 1/8W	07716	CEATO
R75	R: 11K 1% 1/8W	07716	CEATO
R76	R: 3.83K 1% 1/8W	07716	CEATO
R77	R: 11K 1% 1/8W	07716	CEATO
C6, C7	C: 6.8pf 1Kv	71590	DD 6R8

RECEIVE section miscellaneous

C8	C: 50μF 75V NP	13606	D-27359
R5	R: 360Ω 10% ½W	01121	RC20
T4	Transformer	80223	A-20
J12	Binding post: uninsulated	83330	137-SP
J13	J: type 310 telephone	82389	5J-1329
J14	J: type 310 telephone	82389	5J-1192
J15, J16	Binding post: black insulated		5595-175-0
J17	Binding post: red insulated		5595-175-2
S10, S12	S: toggle 3P/DT	09353	7301
S11	S: toggle 4P/DT	09353	7401
S13	S: toggle SP/DT	09353	7101
S15	S: toggle DP/DT	09353	7201
S18/19	S: rotary (concentric snap)	76854	PA-620-046-0AA

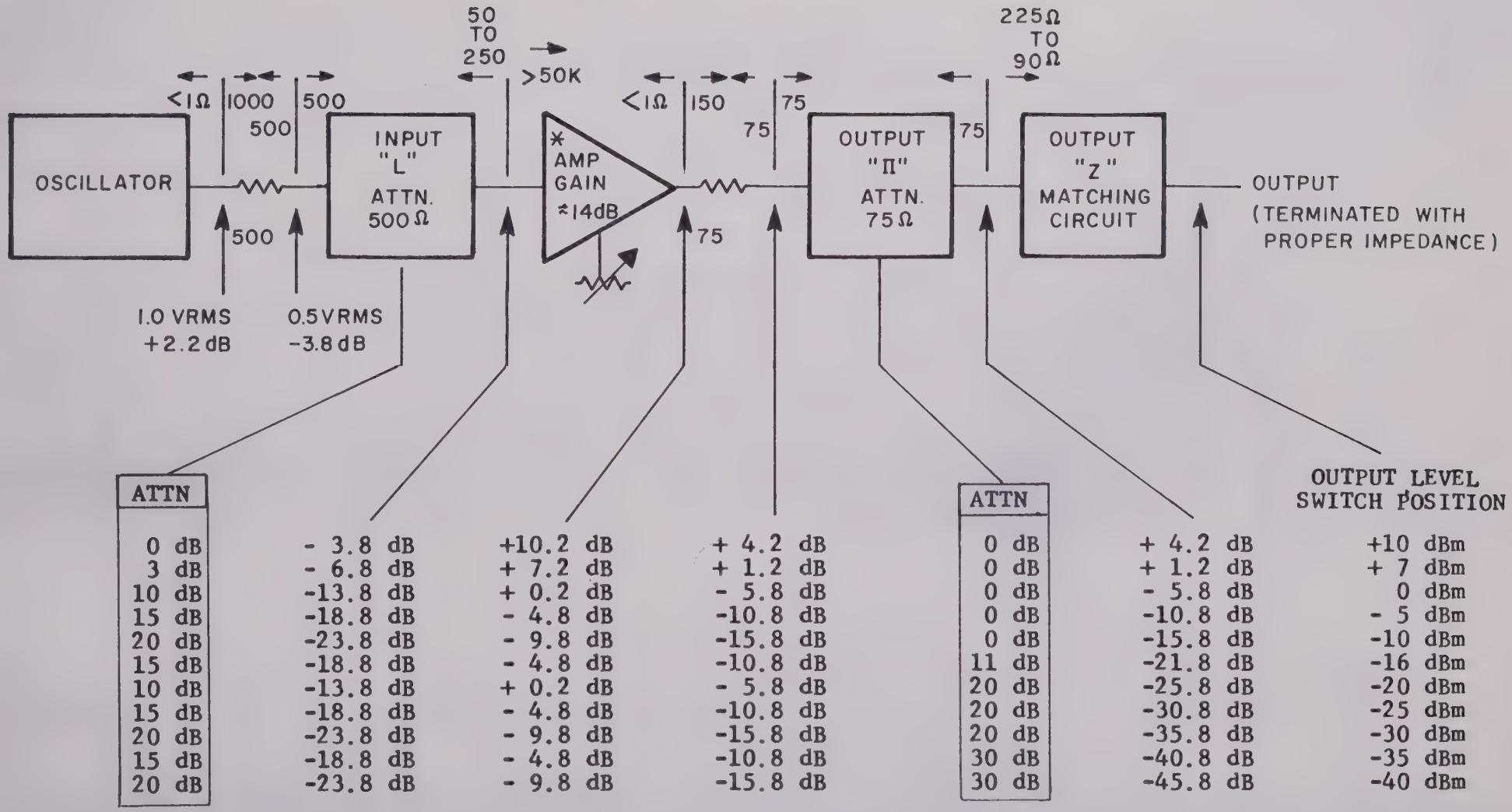
POWER section

T5	Transformer	Stancor*	P-8394
S17	S: toggle DP/3 position	09353	7203
J19	AC receptacle	82389	AC3G
J18	CO Battery jack	82389	L112B

SECTION 7

SCHEMATIC DIAGRAMS

7.1 INTRODUCTION. The following pages contain the schematic diagrams for the Model TTS 4C.

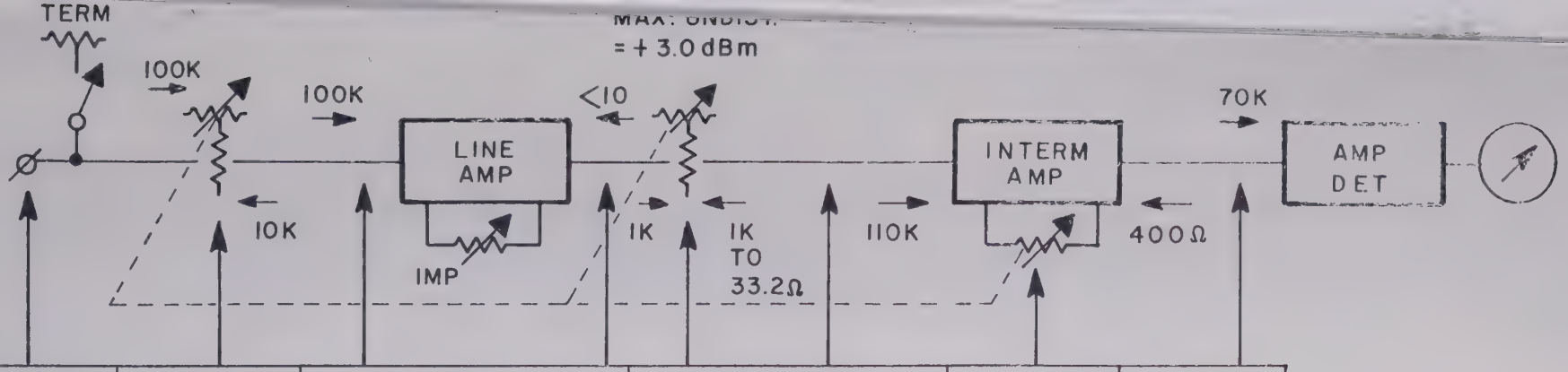


ATTN				ATTN		OUTPUT LEVEL SWITCH POSITION
0 dB	- 3.8 dB	+10.2 dB	+ 4.2 dB	0 dB	+ 4.2 dB	+10 dBm
3 dB	- 6.8 dB	+ 7.2 dB	+ 1.2 dB	0 dB	+ 1.2 dB	+ 7 dBm
10 dB	-13.8 dB	+ 0.2 dB	- 5.8 dB	0 dB	- 5.8 dB	0 dBm
15 dB	-18.8 dB	- 4.8 dB	-10.8 dB	0 dB	-10.8 dB	- 5 dBm
20 dB	-23.8 dB	- 9.8 dB	-15.8 dB	0 dB	-15.8 dB	-10 dBm
15 dB	-18.8 dB	- 4.8 dB	-10.8 dB	11 dB	-21.8 dB	-16 dBm
10 dB	-13.8 dB	+ 0.2 dB	- 5.8 dB	20 dB	-25.8 dB	-20 dBm
15 dB	-18.8 dB	- 4.8 dB	-10.8 dB	20 dB	-30.8 dB	-25 dBm
20 dB	-23.8 dB	- 9.8 dB	-15.8 dB	20 dB	-35.8 dB	-30 dBm
15 dB	-18.8 dB	- 4.8 dB	-10.8 dB	30 dB	-40.8 dB	-35 dBm
20 dB	-23.8 dB	- 9.8 dB	-15.8 dB	30 dB	-45.8 dB	-40 dBm

*With vernier set for +10 dBm.

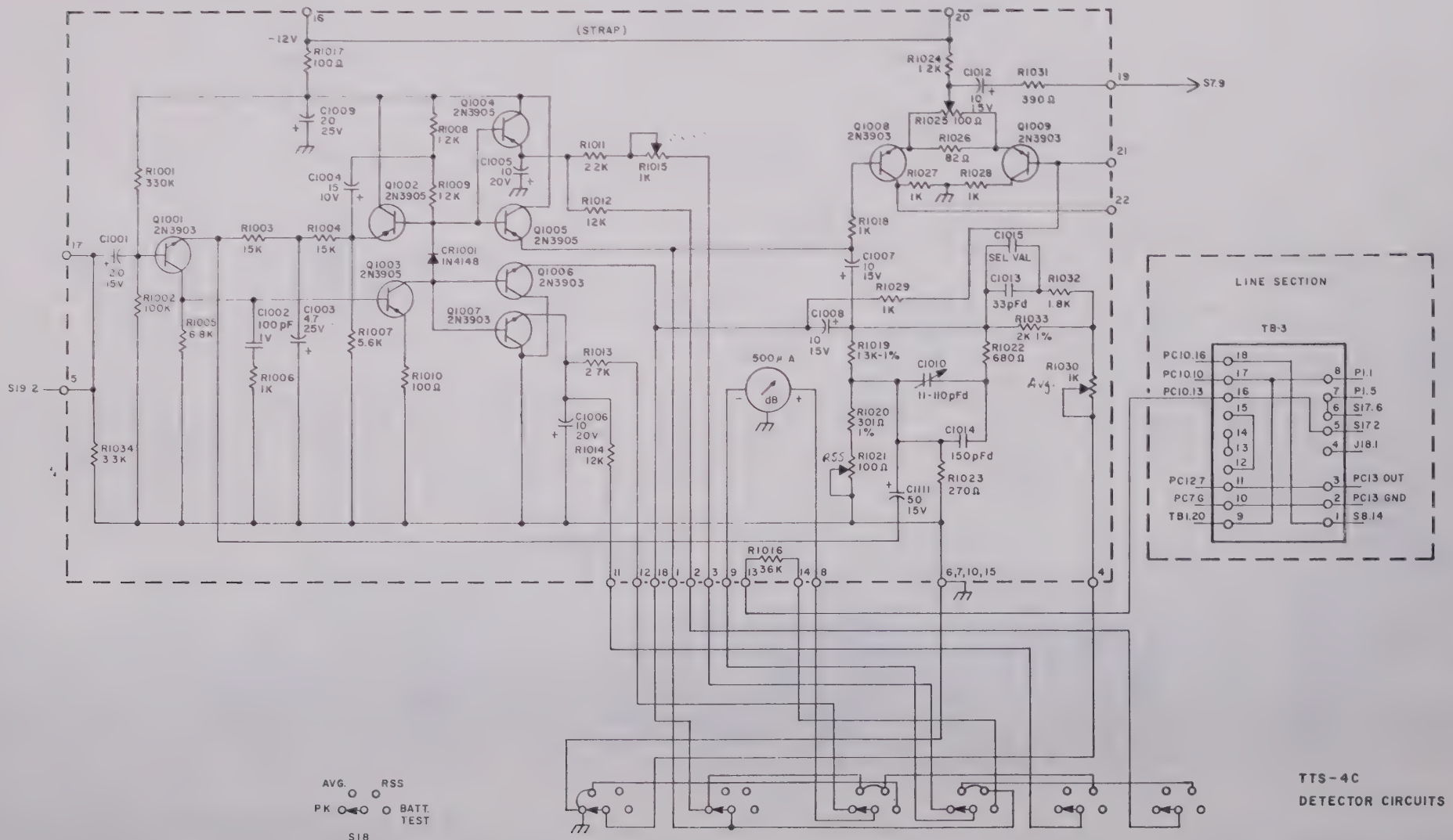
NOTE: dB values are relative to 600 ohms.
dBm values are relative to 75, 135, 150, 600 or 900 ohms.

SEND SECTION LEVEL DIAGRAM

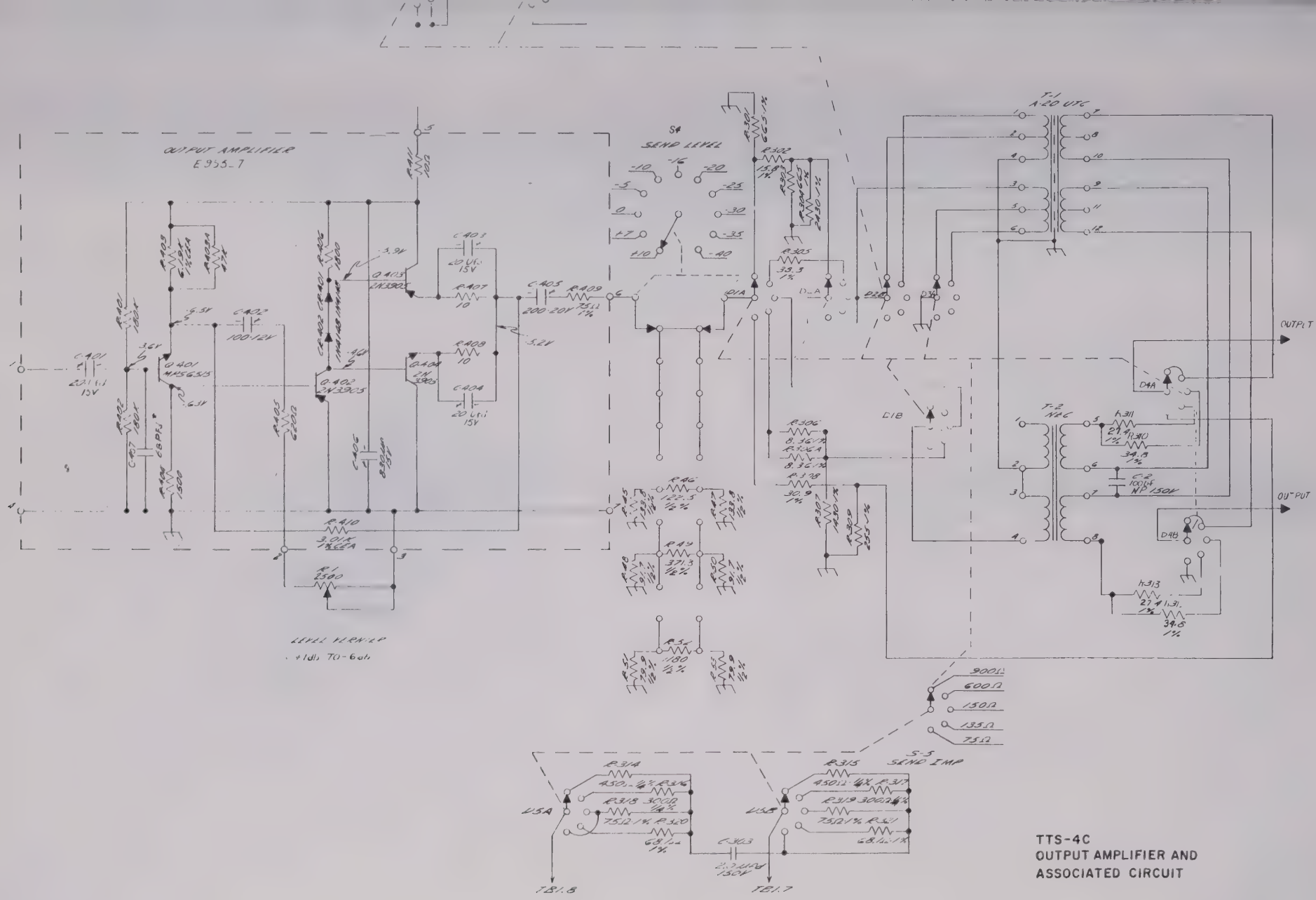


POS.	LINE	LINE ATT.	10 dB LINE AMP INPUT	10 dB LINE AMP OUTPUT	INTERN ATT. ATT.	INTERN ATT. OUTPUT	INTERN AMP. GAIN	AMP. DET. INPUT
1	+10	30	-20	-10	30	-40	20	-20
2	+ 7	30	-23	-13	30	-43	23	-20
3	0	30	-30	-20	20	-40	20	-20
4	- 5	30	-35	-25	20	-45	25	-20
5	-10	30	-40	-30	10	-40	20	-20
6	-16	30	-46	-36	10	-46	26	-20
7	-20	0	-20	-10	30	-40	20	-20
8	-25	0	-25	-15	30	-45	25	-20
9	-30	0	-30	-20	20	-40	20	-20
10	-35	0	-35	-25	20	-45	25	-20
11	-40	0	-40	-30	10	-40	20	-20
12	-45	0	-45	-35	10	-45	25	-20
13	-50	0	-50	-40	0	-40	20	-20
14	-55	0	-55	-45	0	-45	25	-20
15	-60	0	-60	-50	0	-50	30	-20

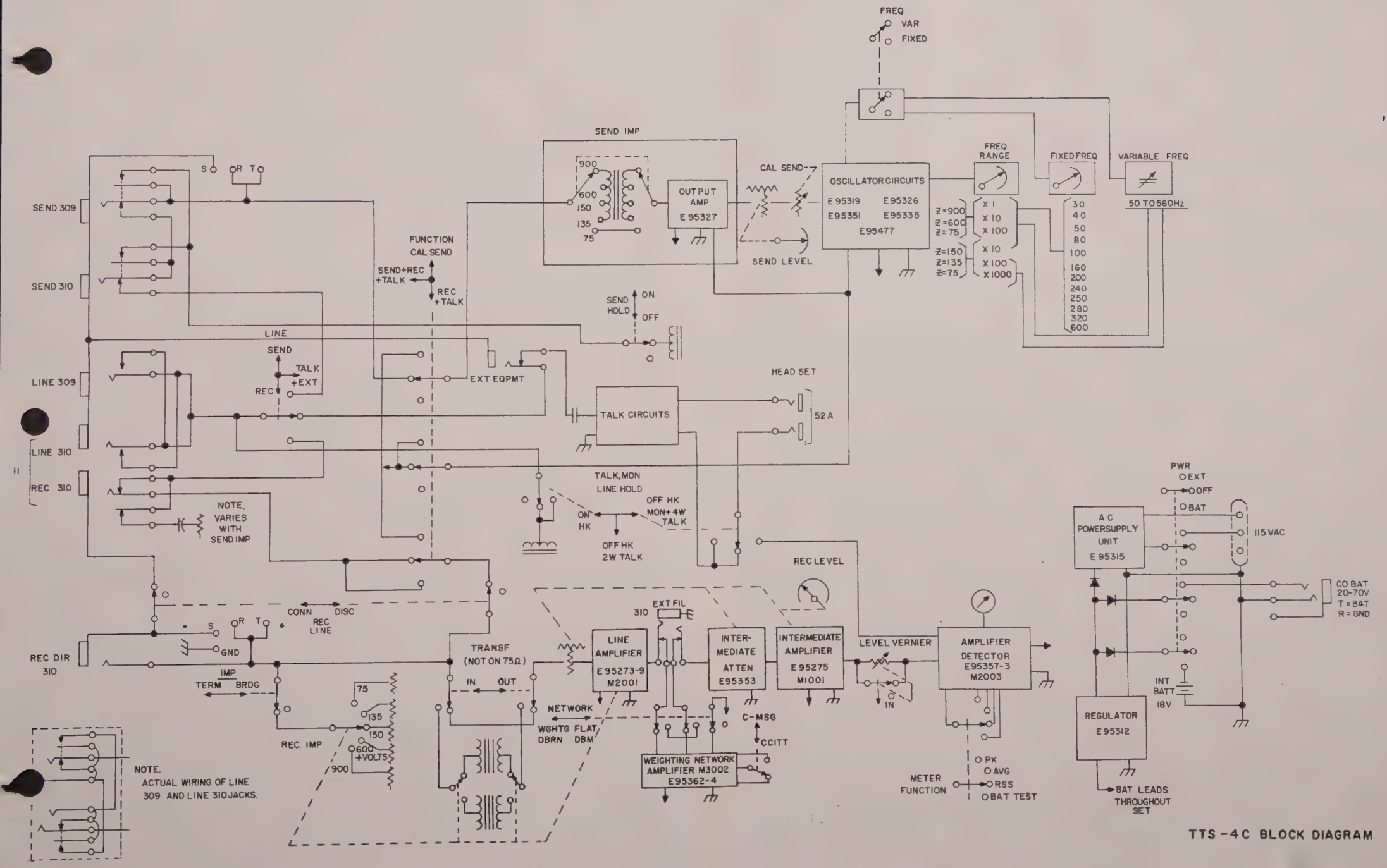
RECEIVE SECTION LEVEL DIAGRAM



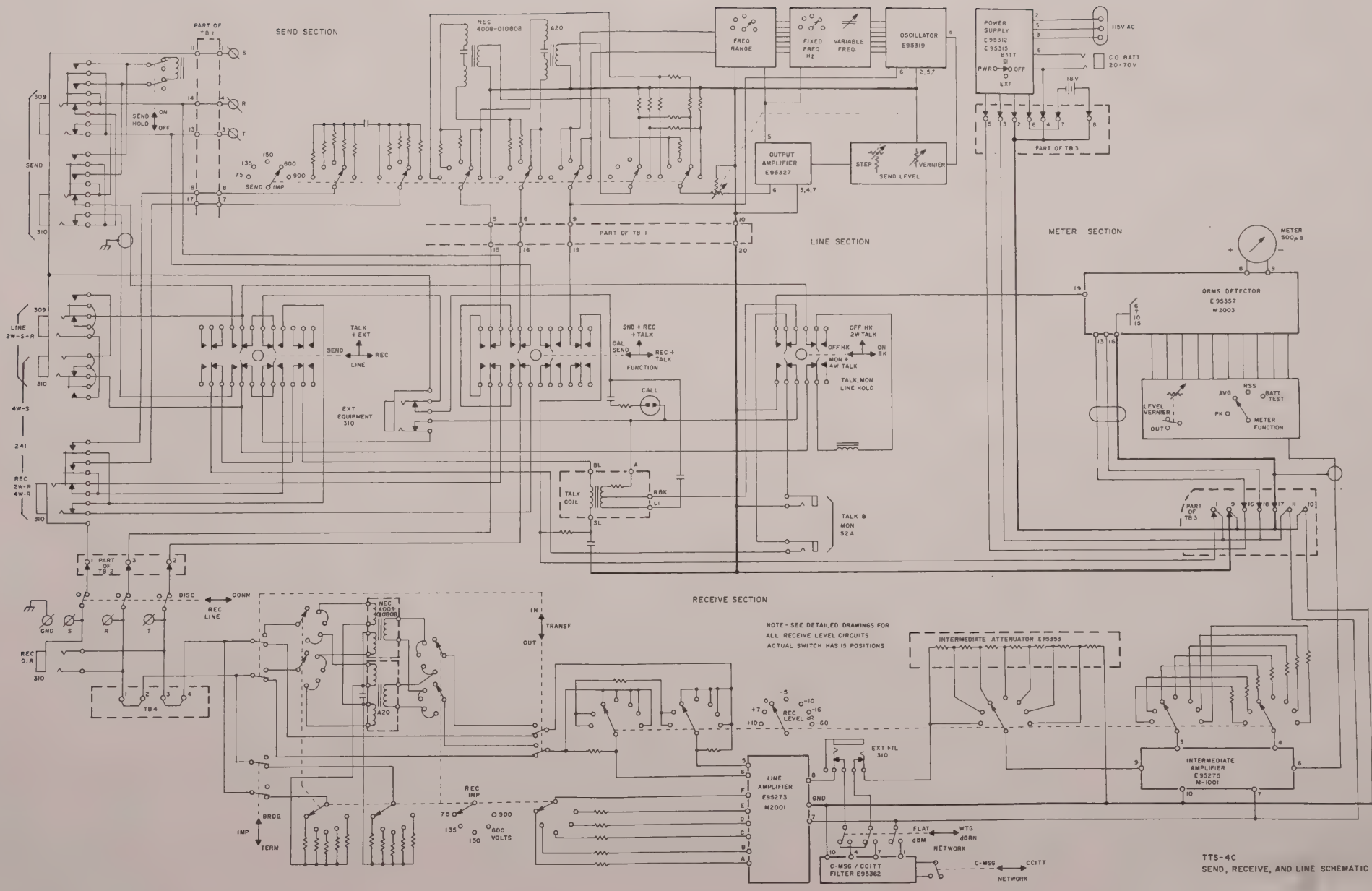
TTS-4C
DETECTOR CIRCUITS



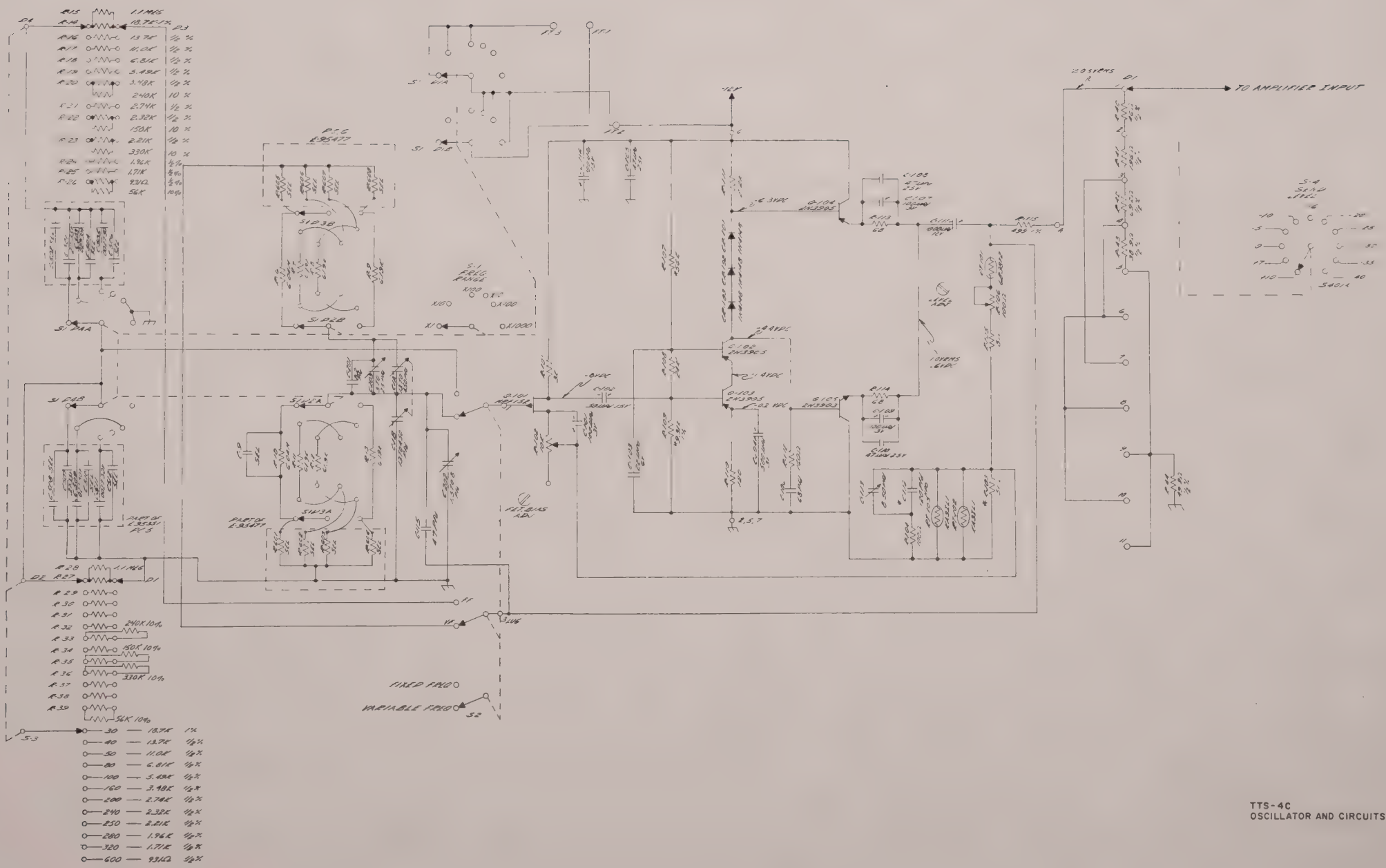
TTS-4C
OUTPUT AMPLIFIER AND
ASSOCIATED CIRCUIT



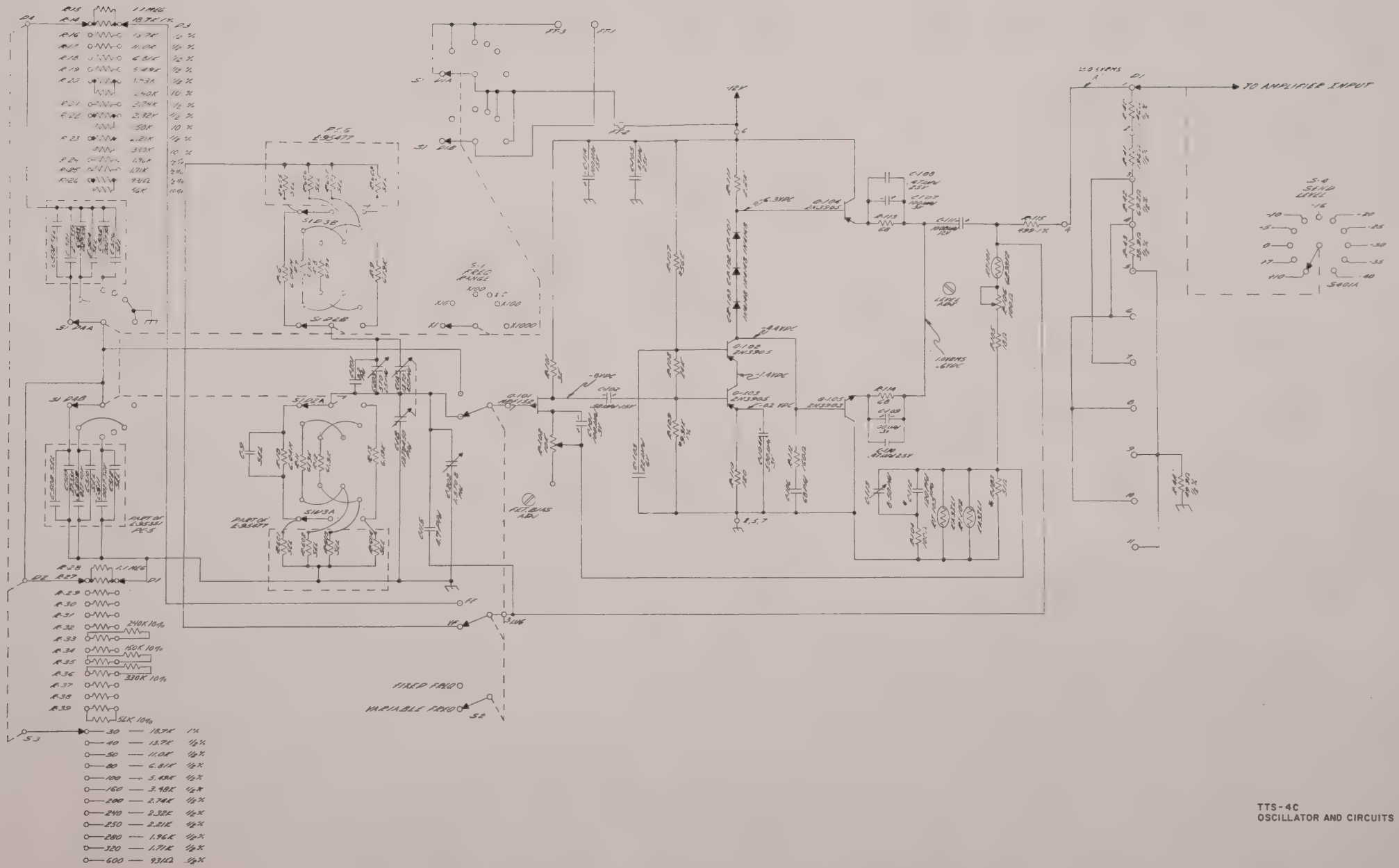
TTS-4C BLOCK DIAGRAM



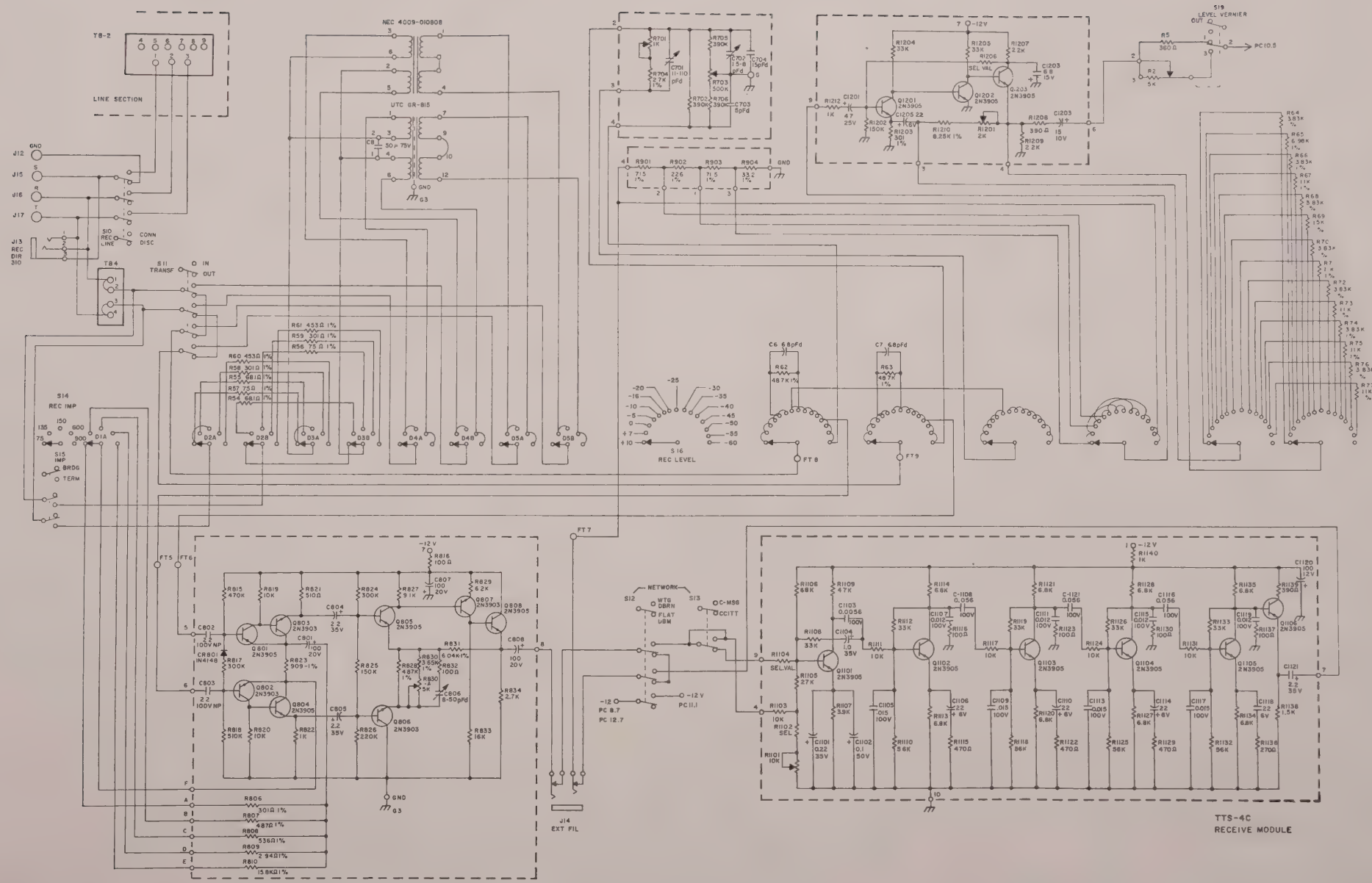
TTS-4C
SEND, RECEIVE, AND LINE SCHEMATIC

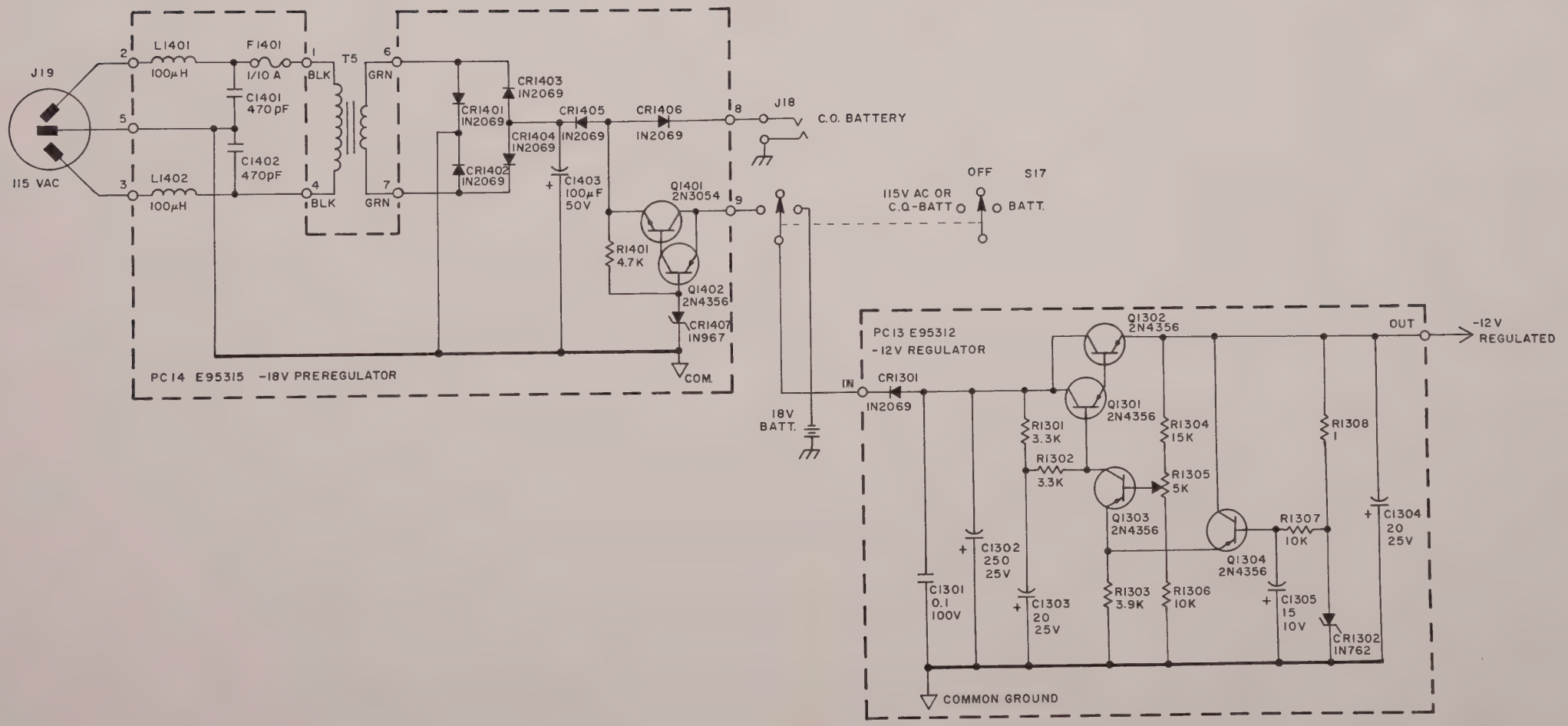


TTS-4C
OSCILLATOR AND CIRCUITS



TTS-4C
OSCILLATOR AND CIRCUITS


T8-2
LINE SECTION
J12
J15
J16
J17
GND
J13 REC DIR 310
S10 REC LINE
CONN DISC
T84
S11 TRANSF
IN
OUT
S14 REC IMP
150
135
600
75
900
D1A
S15 IMP
BRDG
TERM
NEC 4009-010808
UTC GR-815
G3
R61 453Ω 1%
R59 301Ω 1%
R56 75Ω 1%
R60 453Ω 1%
R58 301Ω 1%
R55 681Ω 1%
R57 75Ω 1%
R54 681Ω 1%
D2A
D2B
D3A
D3B
D4A
D4B
D5A
D5B
R701 1K
R704 2.7K 1%
C701 11-110 pFd
R705 390K
C702 1.5-8 pFd
C704 5pFd
R703 500K
R702 390K
R706 390K
C703 5pFd
R901 715 1%
R902 226 1%
R903 71.5 1%
R904 33.2 1%
GND
-12V
R1204 33K
R1205 33K
R1206 SEL VAL
R1207 2.2K
C1203 6.8 15V
Q1202 2N3905
Q1203 2N3905
R1212 1K
C1201 47 25V
Q1201 2N3905
C1205 22 16V
R1202 150K
R1203 301 1%
R1210 6.25K 1%
R1201 2K
R1208 390Ω
C1203 15 10V
R1209 2.2K
S19 LEVEL VERNIER
OUT
PC10.5
R5 360Ω
R2 5K
R64 383K 1%
R65 6.98K 1%
R66 383K 1%
R67 11K 1%
R68 383K 1%
R69 15K 1%
R70 383K 1%
R71 1K 1%
R72 383K 1%
R73 11K 1%
R74 383K 1%
R75 11K 1%
R76 383K 1%
R77 11K 1%
-25
-20
-30
-16
-35
-10
-40
-5
-45
0
-50
+7
-55
+10
-60
S16 REC LEVEL
C6 68pFd
R62 487K 1%
C7 68pFd
R63 487K 1%
FT8
FT9
FT7
FT5
FT6
R816 100Ω
C807 100 20V
R829 6.2K
R815 470K
R819 10K
R821 510Ω
R824 300K
R827 9.1K
Q807 2N3903
Q808 2N3905
C804 2.2 35V
Q805 2N3905
C802 100VNP
Q803 2N3903
C801 100 20V
Q801 2N3905
CR801 IN4148
R817 300K
R823 909-1%
R831 6.04K 1%
R830 3.65K 1%
R828 487Ω 1%
R832 100Ω
R825 150K
R830 5K
C806 8-50pFd
C803 2.2 100VNP
Q802 2N3903
Q804 2N3905
C808 100 20V
R834 2.7K
C805 2.2 35V
Q806 2N3903
R818 510K
R820 10K
R822 1K
R826 220K
R833 16K
GND
G3
R805 301Ω 1%
R807 487Ω 1%
R806 536Ω 1%
R809 2.94Ω 1%
R810 15.8KΩ 1%
NETWORK
S12
WTG DBRN FLAT 0dBM
S13
C-MSG
CCITT
-12
PC 8.7
PC 12.7
-12 V
PC 11.1
J14 EXT FIL
-12 V
R1140 1K
R1106 68K
R1109 47K
R1114 6.8K
C-1108 0.056
R1121 6.8K
C-1121 0.056
R1128 6.8K
C1116 0.056
R1135 6.8K
C1139 390Ω
C1103 0.0056
C1104 1.0 35V
R1106 33K
R1111 10K
R1112 33K
C1107 0.012 100V
C1115 100Ω
R1117 10K
R1119 33K
C1111 0.012 100V
R1123 100Ω
R1124 10K
R1126 33K
C1115 0.012 100V
R1130 100Ω
R1131 10K
R1133 33K
C1119 0.012 100V
R1137 100Ω
C1120 100 12V
Q1106 2N3905
R1104 SEL VAL
Q1101 2N3905
Q1102 2N3905
Q1103 2N3905
Q1104 2N3905
Q1105 2N3905
C1121 2.2 35V
R1105 27K
R1103 10K
R1102 SEL
R1101 10K
R1107 3.3K
C1101 0.22 35V
C1102 0.1 50V
C1105 015 100V
R1110 5.6K
C1106 22 6V
R1113 6.8K
R1115 470Ω
C1109 015 100V
R1118 8.6K
C1110 22 6V
R1120 6.8K
R1122 470Ω
C1113 015 100V
R1125 5.6K
C1114 22 6V
R1127 6.8K
R1129 470Ω
C1117 015 100V
R1132 5.6K
C1118 22 6V
R1134 6.8K
R1136 270Ω
R1138 1.5K
TTS-4C
RECEIVE MODULE



TTS-4C
POWER SUPPLY

APPENDIX 1

GENERAL OPERATING INSTRUCTIONS

1 OPERATION

.2 Open the Cover. It may be removed sliding it off its hinges.

.3 Select the Source of Power. If it is ired to operate on ac, insert the spec- cord which is provided into the recep- e marked AC on the Set and the other e into an ac outlet. Move the PWR tch to the EXT position.

t is desired to operate from a central ice battery, FIRST insert a 310 ended d into the set and then connect the er side to the source of power. Move PWR switch to the EXT position. Any ntral office battery with a voltage bet- en 20 and 70 volts may be used. When connecting the set, FIRST remove the rd from the source of power and then move it from the set.

CAUTION: DO NOT CHANGE THE SEQUENCE OF CONNECTING OR DISCONNECTING THE DC POWER CORD.

it is desired to operate from internal tteries, move the PWR switch to the AT position. Check the condition of the ternal batteries by moving the METER UNCTION switch to the BAT TEST posi- on. If the meter reads below the green c, replace batteries.

.4 Select the METER FUNCTION. To this, turn the METER FUNCTION switch the desired position. Unless otherwise ecified in the test procedures, use the erage (AVG) position. Make sure that e LEVEL VERNIER control is in the OUT sition by turning it fully clockwise until click is felt.

A1.5 Calibrate the Set.

To calibrate the set, proceed as follows:

A. Receive Section

1. Make sure that the LEVEL VERNIER control is in the OUT position by turning it fully clockwise until it clicks.

2. Set the METER FUNCTION switch in the average (AVG) position.

3. Set the REC LEVEL switch in the 0 dBm (CAL) position.

4. Turn the REC IMP switch to 600Ω. Move the following switches to the positions indicated.

5. REC LINE to connect (CONN).

6. TRANSF to IN.

7. NETWORK (left switch) to FLAT DBM.

8. NETWORK (right switch) to C MSG position.

9. IMP to TERM.

B. Line Section

1. Move the FUNCTION switch to CAL SEND position.

C. Send Section

1. Set the frequency selection controls to produce a 1000 Hz signal.

2. Set the SEND LEVEL control to 0 dBm (CAL).

3. Set the SEND IMP switch to 600Ω.

4. Now adjust the SEND LEVEL vernier to produce a 0 dBm reading on the meter and lock the control in this position.

D. Receive Section.

If the receive section is to be used in a circuit with a different impedance than the send section, move the REC IMP switch to that position. The gain of the receive section is automatically changed by the proper amount when another receive impedance is selected; therefore, the receive section remains calibrated at any setting of the REC IMP switch.

E. Line Section.

Return the FUNCTION switch to the SND+REC+TALK position; the set is now ready for use.

F. Notes on Special Operations.

1. If it is desired to calibrate the send level at a different send frequency than 1000 Hz, insert this frequency in step C1.

2. If the send section is to operate at another impedance than 600Ω, then change Steps A4 and C3 from 600Ω to the desired impedance in the calibration procedure.

3. To send any level which is not present on the SEND LEVEL switch, change steps A3 and C2 from "set the REC LEVEL switch to the 0 dBm (CAL) position" to "set the level switch to a position which is within ±3 dB of the desired level"and change step C4 to: "Produce the desired level reading" on the meter.

CAUTION: IN THIS CONDITION, THE LEVELS MARKED ON THE SEND LEVEL SELECTOR SWITCH ARE INCORRECT AND SHOULD NOT BE USED.

4. To measure deviations from a predetermined receive level, which is not available on the REC LEVEL switch, set the send section to this level as described above and then adjust the receive LEVEL VERNIER control until a 0 dB reading is observed. NOTE: it may be necessary to turn the REC LEVEL control one step up or down.

CAUTION: THIS LEAVES BOTH THE SEND AND THE RECEIVE LEVEL IN AN "UNCALIBRATED" CONDITION: I.E., THE MARKINGS ON THE LEVEL SELECTOR SWITCHES ARE NOW INCORRECT AND SHOULD NOT BE US

A1.6 Connect the Set to the Circuit.

It is assumed that the set has been calibrated for normal operation by following steps A through E above. To connect the set to the circuit under test, proceed as follows:

A. Normal Operation.

1. Two-wire Circuits.

Connect the circuit under test to the LINE jacks, using either a 309 or 310 equipped cord and connect a 52A or equivalent headset to the TALK and MON jacks. Dialing on the line circuits can be performed in one of two ways.

a. If the line has been connected to the 310 line jack, an external dial may be inserted in series with the test set by connecting it to the 309 line jack. Similarly, if the line is connected to a 309 jack, an external dial may be connected in the 310 jack.

b. To use the dial circuit, which is provided in the cover of the TTS 4C, the line is connected to the terminals or jack marked LINE in the cover and the jack marked TTS 4C TEST SET (310) is connected by means of a patch cord to one of the LINE jacks of the TTS 4C. In this case, a short is applied across the circuit when the dial is in the "off normal" position. In addition, the switch should be in the DIAL+TEST SET (ON) position. When this switch is in the ON HOOK (OFF) position, it can connect a ringer, which can be mounted in the cover.

By means of the TALK-MON-LINE HOLD switch, the test set may be placed in an on hook or an off hook condition. In either condition, the SEND TALK and RECEIVE functions can be performed. The receive signal may be monitored by moving the TALK-MON-LINE-HOLD switch to the MON+4W TALK position; in this case the REC LEVEL switch should be turned to obtain a comfortable level in the receiver.

2. Four-Wire Circuits.

Connect the 310 LINE jack which is marked 2W-S+R, 4W-S to the send side of the circuit under test and the REC jack which is marked 2W-R, 4W-R to the receive side; connect a 52A headset or equivalent to the TALK + MON jack. The LINE switch now permits selection of the SND, TALK and REC functions. The TALK & MON switch should be moved to the MON +4W TALK position. In this case, the headset receiver is connected to the monitor output of the RECEIVE section. Therefore the REC LEVEL control must be turned to obtain the desired level. In the REC position, a termination is connected to the SEND circuit. The setting of the SEND IMP switch determines the value of this termination which has a 2.0 mf condenser in series with it. For further details, see the Description section.

B. Special Operations.

1. To obtain a precision termination, insert a dummy plug in the REC jack and the circuit to be terminated in the LINE 310 (2W-S+R, 4W-S) jack and turn the SEND IMP switch to the desired impedance.

DO NOT USE ON 75Ω.

2. To use the receive section separately and to disconnect it from all the wiring in the line section, move the REC LINE switch to the DISC position and connect to the REC DIR jack or the R+T terminals. Note that the S terminal is connected to the sleeve of the REC DIR jack. A transformer can be inserted in this application by using the TRANSF switch. In this application, no hold coil is provided.

3. To use the SEND section separately, calibrate it in the manner described above and insert a 310 or 309 cord into the SEND jacks. This automatically disconnects the circuits from the LINE circuits and connects a separate hold coil to the SEND section under the control of the SEND HOLD switch. To use the T+R terminals, a dummy plug must be inserted in one of the SEND jacks.

4. To measure transmission losses of any device which requires a dc closed loop at either or both sides, use the SEND section separately as described in step 3 above and connect the receive side of the device under test to the LINE jacks. In this application, move the LINE switch to the REC position and make sure that the REC LINE switch is in the CONN position. This method may be used to test cord circuits or the transmission through a complete central office.

5. To use the LINE section when the SEND and RECEIVE jacks are being used separately, no special provisions are required beyond connecting a 52A or equivalent headset to the TALK and MON jacks.

6. For further details about the special operations, consult the General Description section.

A1.7 Terminate Tests.

Move the PWR switch to the OFF position. If the set is to be moved to another location, remove all cords and the headset. Reattach the cover if it was disconnected and close it. When disconnecting the set, first remove the cord from the source of power and then remove it from the set.

CAUTION: DO NOT CHANGE THE SEQUENCE OF CONNECTING OR DISCONNECTING THE DC POWER CORD.

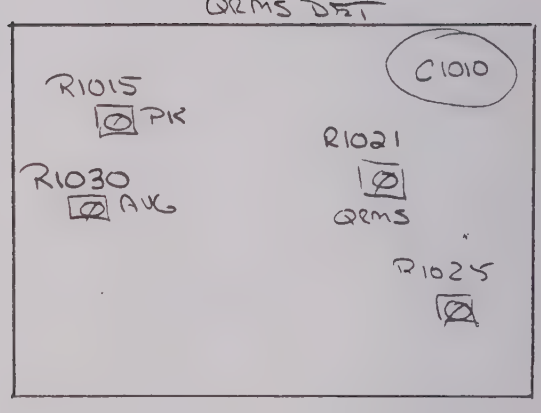
A1.8 Noise to Ground Measurements.

The cover contains circuits which provide measurements of Noise to Ground. To make these measurements, the line is connected to the LINE jacks (309 or 310) or the T and R binding post and a ground is connected to the ground terminal in the cover. This connects the signal to be measured to the input of the 40 dB Noise to Ground attenuator.

Next, connect a cord from the Noise to Ground jack (310), the output of the 40 dB noise to ground attenuator, to the line jac or the T+R binding post of the Receive Se tion.

Permit

CAUTION
CHANGES HAVE BEEN M
ON THIS PAGE.
SEE ISSUE SHEET.
12/3?/9



LOCATED BEHIND
METER

BARCODE 03571
ESC-1093-92-01

TTS 4C TTS 4CR CALIBRATION PROCEDURE

RECEIVE SECTION

CALIBRATION

This unit has been carefully calibrated and tested before
ipment and should not need recalibration except in cases of
g or misuse. If recalibration is required, the following steps
uld be taken using the recommended equipment shown in Table 4-1.

Table 4-2 represents a brief description on location of all calibration adjustment potentiometers and trimmer capacitors.

TABLE 4-1

Description	Manufacturer and Model
A C Voltmeter	H.P. 400FL or equivalent.
Signal Generator - 100 Hz to 1 MHz capability normally 0 dBm output (75 and 600 ohms output impedance).	H.P. 652A or equivalent.
High frequency oscilloscope	Tektronix 535 or equivalent.
Attenuation Network	Daven Type VT795G or equivalent.
Multimeter	Triplett Model 630NA or equivalent.
Distortion Analyzer	H.P. Distortion Analyzer 333A or equivalent.

TABLE 4-2

Location	Ref. Design.	Purpose
ard #8 ne Amplifier	R830A	Adjust for approximately 10 dB of gain of the LINE Amplifier.
	C806	Adjust for an optimum frequency response for the LINE Amplifier at 1 MHz.
oard #7 0 dB Attenuation nd freq. adjust.	R701	Adjust for 30 dB of attenuation at 1 kHz.
	R703	Adjust for input balance at 1 kHz.
	C701	Adjust for high frequency, 30 dB attenuation.
	C702	Adjust for input balance at 100 kHz.

Location	Ref. Design.	Purpose
Board #12 20-30 dB amp.	R1201	Adjust for approximately 20 dB of gain of the 20-30 dB amplifier.
Board #10 Q-RMS Detector	R1015	With an input of 0 dBm at 1 kHz, adjust for a 0 dBm meter output (M-1) with the METER FUNCTION switch (S-18) in PK position.
	R1021	With an input of 0 dBm at 1 kHz, adjust for a 0 dBm meter output (M-1) with the METER FUNCTION switch (S-18) in RSS position.
	R1030	With an input of 0 dB at 1 kHz, adjust for a 0 dBm meter output (M1) with the METER FUNCTION switch (S-18) in AVG position.
	C1010	Adjust for a 0 dBm meter output (M1) with an output of 0 dBm at 1 MHz with the METER FUNCTION switch (S-18) in the RSS position.

4.4 Set the front panel controls on the TTS 4C as follows:

Control	Setting
PWR switch	ON
METER FUNCTION switch	RSS
VERNIER OUT	DETENT position
REC LEVEL switch	-20 dBm
REC IMP switch	600 ohms
IMP switch	BRDG
NETWORK switch	FLAT DBM
TRANSF switch	OUT
REC LINE switch	DISC

4.5 LOW FREQUENCY (1 KHZ)

4.6 30 dB ATTENUATOR and FREQ adj.

Monitor the output (pin 8) of the line amplifier (Board #8 95273) with an AC voltmeter and adjust the input level at 1 kHz (600 ohms) for an output level of the line amplifier of -10 dBm. Switch the REC LEVEL switch (S-16) to the -10 dBm position. The output of the line amplifier should drop to a level of approximately -40 dBm. Adjust potentiometer R701 on the 30 dB attenuator board (Board #7 95360) for a drop of 30 dBm. Still

nitoring the output of the line amplifier with an AC voltmeter, verse the polarity of the input signal to the set without anging any other controls. Adjust potentiometer R703 on the dB Attenuator board until no change in the level is appreciably ticed with a reversal of the input signals polarity. Interaction tween these two adjustments does occur and a readjustment of th may be required.

7 20-30 dB AMPLIFIER

Monitor the output (pin 6) of the 20-30 dB AMPLIFIER (Board 2 95275) with an AC voltmeter. Set the VERNIER OUT in the de- nted position and adjust the input signal for -50 dBm. Set the voltmeter for -30 dB range and adjust the input signal for a ro (0) level on the AC voltmeter. Switch the AC voltmeter to 0 dBm range and the REC LEVEL to -60 dB. Adjust potentiometer 201 on the 20-30 dB AMPLIFIER (Board #12 95275) for a -20 dBm ading on the AC voltmeter.

8 Q-RMS DETECTOR

Set the front panel controls on the TTS 4C as follows, aving all other controls in their initial settings.

Control	Setting
REC LEVEL switch	0 dBm
IMP switch	TERM

Monitor the input level to the test set using the AC voltmeter nd adjust the oscillator for a 0 dBm reading at 1 kHz. Adjust otentiometers R1015, R1021 and R1030, located on the Q-RMS board Board #10 95357) for an approximate mechanical mid-range setting. ext adjust R830A, located on the line amplifier board (Board #8 5273) for an approximate 0 dBm reading on the meter (M1). Adjust otentiometer R1021 for a 0 dBm reading on the meter. Switch the ETER FUNCTION switch (S18) to the AVG position and adjust R1030 or a 0 dBm indication on the meter. Switch the METER FUNCTION switch S18) to the PK position and adjust R1015 for a 0 dBm reading on the eter. Switching the METER FUNCTION switch should keep a constant eading of 0 dBm on the output meter with an input of 0 dBm to the est set.

9 REC LEVEL Switch (S16)

Tracking at 1 kHz of the REC LEVEL switch should be ± 0.15 dB rom +20 dBm to -55 dBm setting, and ± 0.2 dB for the -60 dBm setting. ome adjustment of R701, located on the 30 dB ATTENUATOR board Board #7 95360) may be required for this degree of accuracy.

.10 HIGH FREQUENCY (100 kHz to 1 MHz)

Set the front panel controls of the TTS 4C as follows:

Control	Setting
PWR switch	ON
METER FUNCTION switch	RSS
VERNIER OUT	OUT position
REC LEVEL switch	-20 dBm
REC IMP switch	75 ohms
IMP switch	TERM
NETWORK switch	FLAT dBm
TRANSF switch	OUT
REC LINE switch	DISC

4.11 LINE AMPLIFIER

Monitoring the output of the line amplifier, pin 8, with an AC voltmeter and using 1 kHz (75 ohms) as a reference, set the oscillator for 100 kHz (75 ohms) at -20 dBm and increase to 1 MHz while noting for any peaking of the output signal of the balanced amplifier. Adjust trimmer capacitor C806, located on the line amplifier board (Board #8 95273) so that there is a rising response curve at 1 MHz. Readjust the output level of the oscillator for a 0 dB meter reading at 1 kHz and adjust C1010 located on the Q-RMS detector board (Board #10 95357) for a 0 dB indication on the meter.

4.12 30 dB ATTENUATOR

Set the REC LEVEL switch (S16) in the -10 dBm position and after setting the level of the oscillator for 0 dB meter reading at 1 kHz (75 ohms) increase the oscillator frequency to 1 MHz and adjust C701 located on the 30 dB attenuator board (Board #7 95360) for a 0 dB meter reading.

4.13 BALANCE

Set the REC LEVEL switch (S16) to the -10 dB position and set the oscillator at 100 kHz for a 0 dB meter reading. Reverse the polarity of the input and adjust the trimmer capacitor C702 located on the 30 dB attenuator board so that no appreciable level change is noted with repeated reversal of the input signal polarity.

4.14 If any different input levels are wished to be used, refer to the RECEIVE SECTION LEVEL DIAGRAM in section 7 of the manual for the appropriate intermediate signal levels or for tracing an input signal through the circuitry. If any difficulties arise that cannot be rectified by this calibration procedure it is highly recommended that any maintenance be accomplished at our factory.

HAH/mb
8-15-72

TTS 4C TTS 4CR CALIBRATION PROCEDURE

SEND SECTION

.14 CALIBRATION:

Set the front panel controls of the TTS 4C as follows:

Control	Setting
PWR switch	ON
FREQ RANGE switch	X10 FIXED + VAR
FREQ	FIXED
FIXED FREQ Hz	100
SEND LEVEL	0 (CAL)
SEND IMP	600

.15 OSCILLATOR BOARD

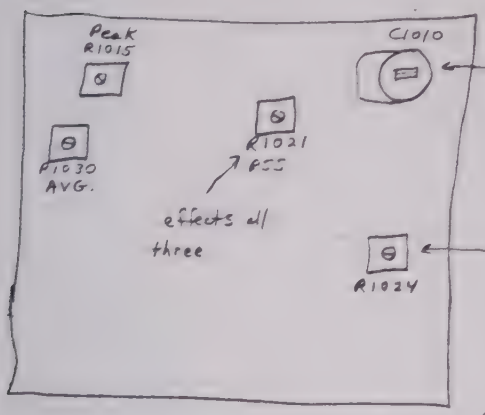
Monitor the output (pin 6) of the OUTPUT AMPLIFIER (Board
4 95327) with a Distortion Analyzer and a High Frequency Oscilloscope.
bserve the output waveform and output level, if no signal exists,
lowly adjust potentiometer R102 on the oscillator board (Board #1
5319) clockwise until a sine wave free of visual distortion is
bserved. Monitor the output (pin 4) of the oscillator board
Board #1 95319) with an AC voltmeter and adjust potentiometer
106 on the oscillator board for an output level of .5 VRMS.
he distortion of the output of the output amplifier (pin 6) should
e less than .5%. Readjustment of these two potentiometers will
educe the distortion.

.16 If this calibration procedure does not correct any fault in the circuitry, along with the SEND SECTION LEVEL DIAGRAM in ection 7, it is highly suggested that the unit be sent back to ur factory for maintenance.

AH/mb
-15-72

...meter

Zero db adjustments
Out level version must be in off position. (click)



Persist

CAUTION
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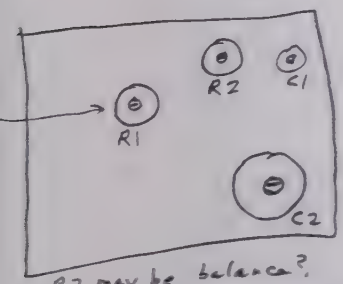
ON THIS PAGE.
SEE ISSUE SHEET
12/13c/93

may vc meter drive linearity for tracking across the meter face. Adj. at -15 db, then re-adj. other pots for zero again. (Adj. other pots for zero first)

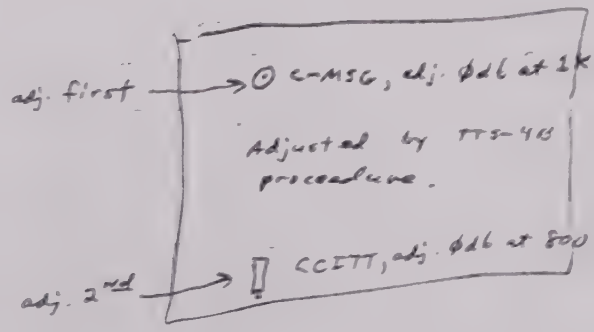
Inside receive cover on right side is adjustable 360 Brd. 20 db (30 db) attenuator, 362 brd. C-MSG filter brd (adjustable),

30 db atten



R2 may be balance?
C2 probably atten. freq. response.

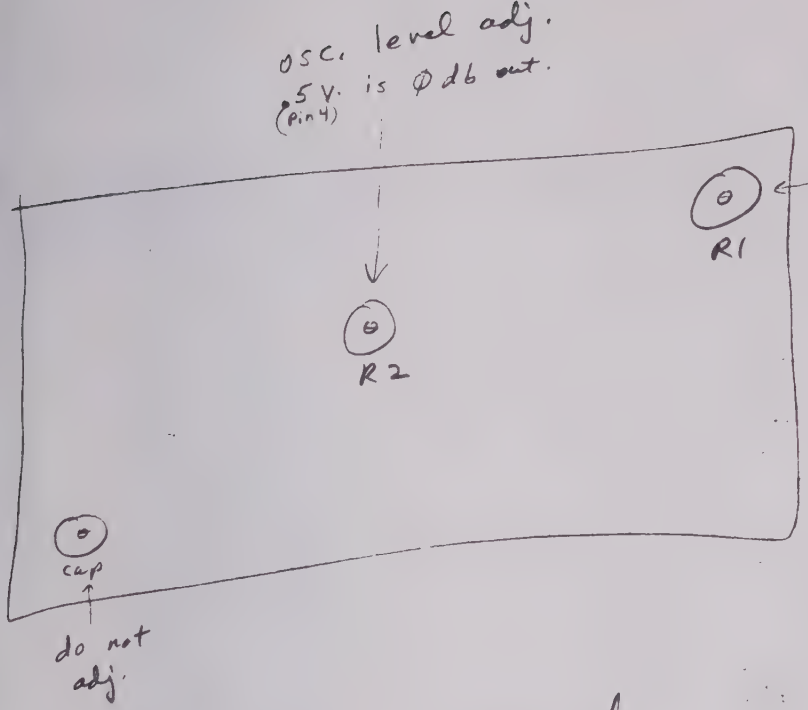
filter Brd
C-MSG/CCITT



...dj. pots on meter board,
...ee above, then go to -10 db,
...ill should be zeroed, then
... to -40, note the amount of
...rror, then go back to -10 db,
...dj. level to equal the error
...t -40 db. Then Re-zero meter

STEP 3

Go to -60 db, adj. pot on Amplifier brd. for -60 db on meter, go to 0 db and readjust RSS pot for 0. Keep repeating until



CAUTION
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12/3-/43

OSC. Board

BARCODE 03456
EGC-1093-92-01

DESCRIPTION	DATE	APP'D
NO CHANGES MADE TO ANY DATA. THIS DOCUMENT IS NO LONGER A MANUFACTURING TEST PROCEDURE (MTP) IT IS NOW AN ENGINEERING PERFORMANCE SPECIFICATION.	1/3/77	E.H. Weir

GE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
V.																						
GE	23	24	25	26	27	28	29	30	31	32	33	34										
V.																						

TLE PERFORMANCE SPECIFICATION

TTS 4C AND 4CR

DRAWN E.H.WEIR	SCALE -------
CHECKED E.H.WEIR	DATE 1/3/77
APPROVED E.H. Weir	DATE 1/3/77
SIZE A	NUMBER 0004-30-401

RANS switch to IN. IMP switch to 150 ohms.

REQ	IMP	PHASE ANGLE
00 Hz	± 10%	$< 10^{\circ}$
1 kHz	± 5%	$< 5^{\circ}$
00 kHz	± 5%	$< 5^{\circ}$

RANSF switch to OUT. IMP switch to 600 ohms.

REQ	IMP	PHASE ANGLE
00 Hz	± 5%	$< 5^{\circ}$
10 kHz	± 5%	$< 5^{\circ}$
100 kHz	± 10%	$< 20^{\circ}$

TRANSF switch to IN. IMP switch to 600 ohms.

FREQ	IMP	PHASE ANGLE
100 Hz	± 5%	$< 5^{\circ}$
10 kHz	± 5%	$< 5^{\circ}$
100 kHz	± 10%	$< 20^{\circ}$

TRANSF switch to OUT. IMP switch to 900 ohms.

FREQ	IMP	PHASE ANGLE
100 Hz	±.5%	$< 5^{\circ}$
10 kHz	± 5%	$< 5^{\circ}$
100 kHz	± 5%	$< 20^{\circ}$

TRANSF switch to IN. IMP switch to 900 ohms.

FREQ	IMP	PHASE ANGLE
100 Hz	± 5%	$< 5^{\circ}$
10 kHz	± 5%	$< 5^{\circ}$
100 kHz	± 10%	$< 20^{\circ}$

DWG #A-0004-30-401

ND SECTION

Connect a GR cord from the tip and ring binding posts of the send section to the binding posts of the 4800A. Set the 4C END LEVEL switch to the -40 dB position. Ground the 4C to the 4800A for all impedances except 75 ohms. Measure the impedance as follows.

MP switch to 75 ohms.

REQ	IMP	PHASE ANGLE
30 Hz	± 5%	10°
00 kHz	± 5%	10°

MP switch to 135 ohms.

FREQ	IMP	PHASE ANGLE
1 kHz	± 5%	5°
100 kHz	± 5%	5°

IMP switch to 150 ohms.

FREQ	IMP	PHASE ANGLE
1 kHz	± 5%	5°
100 kHz	± 5%	5°

IMP switch to 600 ohms.

FREQ	IMP	PHASE ANGLE
30 Hz	± 5%	10°
10 kHz	± 5%	10°

IMP switch to 900 ohms.

FREQ	IMP	PHASE ANGLE
30 Hz	± 5%	10°
10 kHz	± 5%	10°

LINE SECTION

Connect a tip and ring 310 GR cord from the 4C LINE (4W-S) jack to the 4800A terminals. Place the 4C LINE switch to REC. Insert a 310 plug in the 4C REC (2W, 4W) jack. Measure the impedances of the SEND IMP switch as follows:

75 ohms, 135 ohms, 150 ohms at 10 kHz, ± 5%
600 ohms and 900 ohms at 1 kHz, ± 5%

DWG #A-0004-30-401

POWER SUPPLY CALIBRATION

1. Set the FUNCTION switch to SND + REC + TALK.

2. With a VOM set on the X100 range measure between ground and red wire located on TB-3. A charging action exceeding 1K ohm should be seen.

3. With the PWR switch in the OFF position connect -48V to the CO BATT 20-70V jack via a T+R 310 cord (T = NEG).

4. Switch the PWR switch to the EXT position and adjust the 4C power supply for -12.5 volts. Install the dust cover.

NOTE: After the power supply is set up either the receive or the send section may be calibrated next.

RECEIVE SECTION CALIBRATION

1. Preliminary Settings

REC LEVEL	-20
REC IMP	600
REC LINE	DISC
TRSF	OUT
NETWORK	FLAT (C-MSG)
IMP	TERM
FUNCTION	REC + TALK

CAUTION
CHANGES HAVE BEEN MADE ON THIS PAGE. SEE ISSUE SHEET.
12/30/93 KB

ZIP CORD PATCH
DO NOT USE COAX

2. 30 dB ATTENUATOR AND BALANCE ADJUSTMENT

a. Connect a 400 FL set on the -20 range to the wiper (red wire) of the level vernier pot on the METER FUNCTION switch.

b. Connect the test oscillator set at 1 kHz 600 ohm termination to the tip and ring binding posts of the 4C. Connect the 4C ring to chassis GND.

c. Adjust the test oscillator for a -20 dBm reading on the 400 FL.

d. Switch the REC LEVEL switch to the 0DB (CAL) range and the 400 FL to the -40 range. Adjust R701 (bottom pot) on the 30 dB attenuator (E95300) for a -40.05 dB reading on the 400 FL.

e. Reverse the 4C input and adjust R703 (bottom pot) on the 30 dB attenuator (E95300) to take up half the error from zero. Continue reversing the 4C input and adjusting the pots until a constant -40.05 dB reading is reached.

3. INTERMEDIATE AMPLIFIER

a. Switch the REC LEVEL to -50 and the 400 FL to the -30 range. Adjust the test oscillator for a -30 dB reading on the 400 FL.

b. Switch the 400 FL to the -20 range and the REC LEVEL to the -60 range.

c. Adjust R1201 on the 20 dB amp (E95275) for a -20 dB reading on the 400 FL.

d. Repeat steps a through c until a constant zero reading on the 400 FL is reached.

4. NETWORK

a. Switch the REC LEVEL switch to the 0 (CAL) position and the 400 FL to the -40 range. Adjust the test oscillator frequency for exactly 1000 Hz as measured on the 400 FL. Adjust the test oscillator level for a -40 dB reading on the 400 FL.

b. Switch the 400 FL to the -20 range. Place the NETWORK switch to MTS DBRM. Adjust R1204 on the C-MSG FILTER (E95362) for a -20 dB reading on the 400 FL.

c. Adjust the test oscillator for exactly 1000 Hz. Switch the NETWORK to CCITT. Select R1104 for a -20 dB reading ± 0.05 dB on the 400 FL.

d. Return the NETWORK switches to FLAT (C-MSG), and the test oscillator to 1000 Hz.

5. TERM/BRDG AND XFMR INSERTION LOSS

a. Set REC LEVEL to 0 (CAL) and the 400 FL to the -30 range. Adjust the test oscillator for a -30 dB reading on the 400 FL. Place a precision 600 ohm load across the tip and ring of the 4C. Switch the IMP switch to BRDG. The 400 FL should still read -30 ± 0.1 dB.

b. Switch the TRANSF to IN. LEVEL on 400 FL should not change more than ± 0.15 dB.

c. Repeat steps a and b using corresponding impedances and loads, but do not check the TRANSF switch in the IN position.

6. LEVEL EQUALIZATION

a. Set the REC IMP switch to 600, IMP switch to BRDG and the TRANSF to OUT.

b. Set the 400 FL to the -30 range and adjust the test oscillator for a -30 dB reading on the 400 FL.

c. Switch the IMP switch to 900; the 400 FL should read -31.75, switch to 150; read -24.0, switch to 135; read -23.52, switch to 75; read -21.0. All levels are ± 0.15 dB. Remove the 400 FL.

7. QRMS DETECTOR

a. Set front panel controls as follows:

IMP	TERM
REC IMP	600
REC LEVEL	0
RSS/AUG/PK	RSS
VERNIER	OUT
TRANSF	OUT
NETWORK	FLAT (C-MSG)
REC LINE	DISC
FUNCTION	REC + TALK

b. Connect the test oscillator, 1000 Hz 600 ohms termination, to the 4C tip and ring binding posts with the 4C ring connected to chassis GND. Monitor the 4C input with an unloaded 400 FL set on the 0 dB range. Adjust the test oscillator for a zero reading on the 400 FL.

c. Adjust pots R1015, R1021, R1030 and R1025 on the QRMS DET (E95357) for approximate mechanical mid-range.

d. With the 4C lying in a horizontal position adjust R830 on the balanced amp (E95273) for a zero reading on the 4C meter.

e. Move the 4C to the vertical position. The 4C reading should not change more than ± 0.05 dB. Return set to the horizontal position.

f. Decrease the 4C input by 10 dB. Adjust R1025 for a -10 dB reading on the 4C meter. Return the 4C input to 0 dB and repeat steps d and f until calibration is complete. (NOTE: R1021 may be used for fine calibration of the RSS position).

g. With the 4C meter reading zero, switch the METER FUNCTION switch to AVG and adjust R1030 for a zero reading.

h. Switch the METER FUNCTION switch to PK and adjust R1015 for a zero reading. NOTE: Due to interaction between the RSS and PK pots it will be necessary to switch back and forth between those positions until a constant zero reading is reached.

i. Switch the METER FUNCTION switch to RSS. The LEVEL VERNIER should provide approximately + 1.0 dB to -7.0 dB adjustment. Switch the LEVEL VERNIER to OUT.

j. Meter tracking should be as follows:

+3	±0.1 dB
-3	±0.1 dB
-5	±0.25 dB
-10	±0.5 dB

k. Check the tracking of the 4C REC LEVEL switch to be within ± 0.1 dB.

l. Return the REC LEVEL switch to 0 (CAL). Adjust the test oscillator for a 1000 Hz -20 dB reading at the 4C input. Place the NETWORK switch to WTG DBRN (C-MSG). The 4C meter should read 0 dB ± 0.1 dB. Adjust the test oscillator for a zero reading.

Check the 4C filter response as follows:

	-3 dB	-40 dB
LOWER	570 Hz - 750 Hz	90 Hz - 150 Hz
UPPER	2.1 kHz - 2.9 kHz	4.8 kHz - 7.2 kHz

m. Return the NETWORK switch to FLAT (C-MSG) and remove the oscillator.

8. HIGH FREQUENCY CALIBRATION

USE ONLY COAXIAL CORDS FOR THIS CALIBRATION

a. Set 4C controls as follows:

REC LEVEL	-20
REC IMP	135
IMP	BRDG
METER FUNCTION	RSS
TRANSF	OUT

b. Connect the test oscillator, 1000 Hz 50 ohms termination, to the 4C tip and ring binding posts with the 4C ring connected to chassis GND, load the 4C input with a 50 ohm load.

c. Connect a 400 FL set on the -20 range, 100 kHz L.P. FILTER to OUT to the wiper (red wire) of the level vernier pot on the METER FUNCTION switch.

d. Adjust the test oscillator for a zero reading on the 400 FL meter. Adjust the oscillator to 1 mHz and adjust C806 on the balanced amp (E95273) for approximately -0.6 dB below the 1000 Hz reference. Remove the 400 FL. Return the test oscillator to 1000 Hz.

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e. Adjust the test oscillator for a zero reading on the 4C meter. Tune the oscillator to 1 MHz. Adjust C1010 on the QRMS DET (E95357) for approximately + 0.05 dB above the 1000 Hz reference.

f. With the test oscillator at 1 MHz switch the METER FUNCTION switch to AVG. Select C1015 (approximately 27 pf) for the same reading as in RSS. Return the METER FUNCTION switch to RSS.

g. Sweep the test oscillator from 1 kHz to 1 MHz and observe. The 4C meter response as per the following specs:

TRANSFORMER OUT

± 0.1 dB	1 kHz to 100 kHz
± 0.2 dB	100 kHz to 500 kHz
± 0.5 dB	500 kHz to 1 MHz

TRANSFORMER IN

± 0.1 dB	1 kHz to 100 kHz
± 0.5 dB	100 kHz to 500 kHz
± 3.0 dB	500 kHz to 1 MHz

h. Return the test oscillator to 1 kHz. Switch the 4C REC LEVEL to 0 (CAL). Adjust the oscillator for a zero reading on the 4C meter. Check that the input balance is still within tolerance.

i. Increase the test oscillator to 100 kHz. Adjust C701 on the 30 dB attenuator (E95360) for a constant reading when the 4C input is reversed. NOTE: If a constant reading cannot be reached it will be necessary to increase the value of or remove C703 on the 30 dB attenuator (E95360).

j. Increase the test oscillator to 1 MHz. Adjust C701 on the 30 dB attenuator (E95360) for + 0.1 dB above the 1 kHz reference. It may be necessary to readjust C701 if the 4C does not meet the following specs:

TRANSFORMER OUT

± 0.1 dB	1 kHz to 100 kHz
± 0.2 dB	100 kHz to 500 kHz
± 0.5 dB	500 kHz to 1 MHz

TRANSFORMER IN

± 0.1 dB	1 kHz to 100 kHz
± 0.5 dB	100 kHz to 500 kHz
± 3.0 dB	500 kHz to 1 MHz

k. Set the REC IMP switch to 75 and the IMP switch to TERM. Remove the 50 ohm load.

l. Adjust the test oscillator for 1 MHz and a zero reading on the 4C meter. Check the REC LEVEL switch to be within ± 1.0 dB in all positions of the switch except the -60 position which should be within ± 2.0 dB.

m. Remove all cords, return all switches to their normal positions and turn off set.

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SEND SECTION CALIBRATION

1. VISUAL CHECKS

   a. Check that there is a slight amount of play in the universal drive, approx. 1/16 to 1/8 inch. If not, adjust.

   b. Check spacing of plates in the air capacitor. None should touch and the movable plates should shift on slightly from side to side when turned.

   c. Check that 50 on the dial lines up on the hairline or just slightly to the right of the hairline. If not, adjust.

   d. Check for excessive dial wobble.

2. CALIBRATION

   a. Set front panel controls as follows:

FREQ RANGE	X10
FREQ	FIXED
FIXED FREQ HZ	100
SEND LEVEL	+10
SEND IMP	75
FUNCTION	SND+REC+TALK

   b. Adjust all pots on the variable frequency padding board fully clockwise.

   c. Install a 270 pf capacitor for C112 on the oscillator bd.

   d. Turn on power to the set.

   e. Monitor the junction of C102 and R101 with a VOM set on the -12V range. Adjust R102 (front pot) for -8.2 volts.

   f. Connect a VTVM set on the 1.0 volt range to pin 4 of the oscillator board. Adjust R106 (rear pot) for a 0.5 volt reading. Remove the VTVM.

g. Connect a GR cord from the send tip and ring binding posts to a 75 ohm 10 db dropping load which is in turn connected to a 400 FL. Also connect a scope with a frequency range of at least one megacycle and an 80C to the send output. Set the 400FL to the 0 db range with the 100 kHz filter to OUT.

3. VARIABLE CALIBRATION

a. X10 Range

1. Install the test dust cover.

2. Set the FREQ. switch to VAR.

3. Turn the AIR CAP fully clockwise so that the dial reads 50.

4. Adjust the SEND LEVEL VERNIER for a zero reading on the 400FL and lock.

5. Adjust pots R2 and R6 on the variable frequency padding board (see Figure 1) for a frequency of 500 Hz, while maintaining a zero reading on the 400FL.

6. Adjust for a reading of 560 on the dial.

7. Adjust C202 (front trimmer) and C203 (rear trimmer) for a frequency of 5600 Hz while maintaining a zero reading on the 400FL. C202 increases level and frequency or decreases level and frequency. C203 increases level and decreases frequency or decreases level and increases frequency.

8. Due to interaction between the high and low ends, it will be necessary to repeat steps 3 thru 7 several times.

9. After calibration is completed, spot check the dial at 50, 100, 200, 300 and 560. All frequencies should be within ±3%. The level from 50 to 560 should not vary more than ±0.15 db. Check the other X10 range for the same response.

b. X1000 RANGE

1. Set the FREQ RANGE switch to X1000 and set dial for 50.

2. Adjust R4 and R6 (see Fig. 1) for a frequency of 50 kHz while maintaining a zero reading on the 400FL. NOTE: The 10 Hz to 50 kHz filter on the 80C must be in the OUT position.

3. Tune to 560 on the 8 dial. Adjust C113 on the oscillator board (E95319) for a frequency of 560 kHz. If this frequency cannot be reached, C112 will have to be changed. NOTE: If C112 was changed, it will take several minutes for the level to stabalize. With the

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e. Repeat steps a. thru d. substituting 150 ohms for 135 ohms. Specs. are the same.

f. Repeat steps a. thru d. substituting 600 ohms and then 900 ohms. 0 db reference is at 1 kHz. Specs. for 600 ohms and 900 ohms are as follows:

±0.25 db	100 Hz to 20 kHz
±0.5 db	50 Hz to 50 kHz

5. FIXED FREQUENCY CALIBRATION

a. Set front panel controls as follows:

FREQ	VAR
FREQ RANGE	X10
FIXED FREQ HZ	100
SEND LEVEL	+10
SEND IMP	75
VARIABLE FREQ	100

b. Replace 75 ohms 10 db dropping load on output of the 4C.

c. Adjust the SEND LEVEL VERNIER for a zero reading on the 400 FL and lock.

d. Set the FREQ switch to FIXED.

e. Locate C504 and C510 lugs on the bridge fixed capacitors board (E95351) see Fig. 2. Select values of capacitance which will result in a frequency of 1000 Hz±1% and a level of 0db ±0.1 db.

f. Check all the other frequencies on the FIXED FREQ HZ switch. They should all be within ±2% and ±0.1 db. Return switch to 100.

g. Switch to the X100 range.

h. Locate C506 and C512 (see Fig. 2) and select values of capacitance that give a frequency of 10 kHz±1% and a level of 0 db ±0.1 db.

i. Switch to the X1 range.

j. Locate C502 and C508 (see Fig. 2) and select values of capacitance that give a frequency of 100 Hz ±1% and a level of 0 db ±0.1 db.

k. Install all dust covers on the send section. Spot check the low and high ends of all the variable bands and adjust if necessary.

6. DISTORTION CHECK

1. PROCEDURE

a. Terminate output of oscillator at VTVM with 75 ohm. Special load and adjust send level vernier for 0 dB on VTVM on 0 dB range.

b. IMP switch to 75.

c. Step attenuator to +10.

d. Connect Dist. analyzer HP 334A to output terminals.

e. Check distortion at indicated frequencies to be less than 1%.

	Freq.	
X1 Range	50 Hz 560 Hz	
X10 Range	500 Hz 5.6 kHz	
X100 Range	5 kHz 56 kHz	
X1000 Range	50 kHz 560 kHz	- .7% worst case 75 ohm +10 dBm

7. ATTENUATOR TRACKING AND VERNIER RANGE

1. PROCEDURE

a. Connect equipment as shown in Fig. 3.

b. IMP switch to 600 ohm.

c. Step attenuator to 0.

d. HP 400 Series voltmeter to 0 dB range.

e. Check the vernier range. It should have approx. 8 dB overall adjustment.

f. Adjust the vernier range to 0 dB on the HP voltmeter.

g. Turn 4C step attenuator to -5. -5 should now be seen on the HP voltmeter ± .15 dB. Turn the 4C to -10. The reading on the voltmeter should read 0 ± .15 dB.

h. Continue as in step "g" until all the positions of the attenuator have been checked.

8. OUTPUT LEVEL CALIBRATION

1. PROCEDURE

a. POWER switch ON.

b. SEND IMP switch to 600.

c. FREQ to 1 kHz Var position.

d. Set attenuator for -5 dB.

e. Adjust SEND LEVEL VERNIER control to 0 dB on unloaded 400 FL known to be accurate at 0 dB.

f. Switch to 900 ohm and output level should increase to +1.752 dB ± .1 dB.

g. Switch FREQ RANGE switch to X100 scale variable.

h. Switch SEND IMP switch to 150 ohm and output level should decrease to -6.01 dB ± .1 dB.

i. Switch SEND IMP switch to 135 ohm and output level should decrease to -6.48 dB ± .1 dB.

j. Switch SEND IMP switch to 75 ohm and output level should decrease to -9.008 dB ± .1 dB.

9. OUTPUT BALANCE

1. PROCEDURE

a. Connect equipment as indicated by the broken lines in Fig. 4 with the 900 ohm load. (135 ohm load)

b. Set up the TTS 4C as follows:

FREQ	1 kHz, Variable (10 kHz)
IMP	900 (135)
LEVEL ATTEN	+10 (+10)
LEVEL VERNIER	Adjust for +10 dB (0 dB) on the VTVM.

c. Reconnect the equipment as shown by the solid lines in Fig. 4 using the proper split loads for indicated impedances.

d. Change to the indicated frequencies and read balance (balance being the total number of dB below the reference level as read on the VTVM).

FREQ	BALANCE	REF. LEVEL
100 Hz	90 dB	+10 dB @ 900 ohm 1 kHz
3 kHz	70 dB	

e. Repeat entire procedure at 135 ohm impedance.
NOTE: Set up for 135 ohm is parenthesized.

FREQ.	BALANCE	REF. LEVEL
4 kHz	50dB	0 dB @ 135 ohm 10 kHz

For frequencies greater than 4kHz, the longitudinal balance requirements decreases at the rate of 6dB per octave to 560 kHz. Sample test points:

Freq.	Balance
10kHz	>52dB
40kHz	>40dB
100kHz	>32dB
560kHz	>17dB

10. SIGNAL TO NOISE MEASUREMENT

1. PROCEDURE

a. Connect equipment as shown in Fig. 5.

b. Set the 4C as follows:

VARIABLE FREQ.	100
FREQ. RANGE	X10
SEND LEVEL	+10
SEND IMP	600

c. Set the 35B as follows:

REC IMP	600 (TERM)
FILTER	15 KC
SENS	+20

d. Adjust the 4C for a zero reading on the 35B meter.

e. Adjust the 4C oscillator to 560 kHz. Connect jumper as shown in Fig. 5.

f. Measure noise on the 35B. Should be greater than 90 dB.

TTS 4C LINE SECTION

TEST EQUIPMENT REQUIRED

A. VTVM known to be accurate at 0 db.

B. Oscillator adjusted to deliver 0 dbm into 600 ohm at 1000 Hz.

SET UP TTS 4C AS FOLLOWS:

A. TALK switch in 2W OFF HK position.

B. SEND HOLD switch in ON position.

C. FUNCTION switch in SND & REC & TALK position.

D. LINE switch in TALK position.

E. Set SEND FREQ to 1000 Hz, either fixed or variable.

F. SEND IMP switch to 600 ohm.

G. SEND LEVEL switch to 0 db.

H. Patch from SEND 310-309 to VTVM loaded with 600 ohm and adjust SEND LEVEL for 0 db.

I. Set REC LINE switch to CONN.

J. TRSF switch to OUT.

K. NETWORK switch to FLAT DBM.

L. IMP switch to TERM.

M. REC IMP switch to 600 ohm.

N. REC LEVEL to 0 db.

AC TESTS

1. Remove cord from SEND Jack(s) and place in LINE 309-310. Place LINE switch in SEND position. VTVM should read 0 db.

2. Place TALK switch to ON HK position. It should have no visible effect on the signal from the LINE Jack(s). Return switch to original position.

3. Remove cord from LINE Jack(s) and place in SEND R&T terminals.

4. Move LINE switch through all positions. No visible effect should be seen on signal from SEND R&T terminals.

5. Move FUNCTION to CAL SEND position. Signal from SEND R&T terminals should disappear. Internal meter should now read 0 dB.

6. Move FUNCTION switch to REC & TALK position. Both signals, the one to the internal meter and the one from SEND R&T terminals should disappear.

7. Return all switches to mid-position.

RECEIVE FUNCTIONS

1. Move LINE switch to REC position and connect external OSC at 1000 Hz to LINE jack (s) through 10 dB of ATTEN. (DAVEN or TN-7).

2. Monitor output of attenuator with unloaded VTVM.

3. Adjust oscillator so both meters read 0 dB.

4. Insert dummy plug in REC 2WR-4WR jack, remove and insert in EXT. FIL. In both cases signal should disappear on internal meter but remain on VTVM.

5. Remove dummy plug and signal should reappear on internal meter.

6. Switch VTVM to +10 scale and switch REC line to DISC position. Internal meter signal should disappear while VTVM will rise to +4 dB.

7. Return REC line switch to CONN position and REC LEVEL to +10.

8. Disconnect VTVM from ATTENUATOR output and connect to REC R&T terminals. Switch IMP switch to ERDG position. Both meters should rise to +4 dB.

9. Return REC IMP switch to TERM position and VTVM to 0 dB range, and 4C REC LEVEL to 0 (CAL).

10. Move FUNCTION switch through all positions and both meters should remain at 0 dB.

11. Place FUNCTION switch to CAL SEND and SEND LEVEL to -10 dB. Internal and external meter should drop correspondingly.

12. Return SEND LEVEL to 0 dB. Remove external OSC from LINE Jack (s) and place in REC DIR jack. Place REC LINE switch to DISC and both meters should still read 0 dB.

13. Remove all cords and place switches in original positions.

TALK AND EXTERNAL CIRCUITS

1. Insert a 52A or equivalent headset into the TALK & MON jacks. Connect an ohmmeter calibrated on X100 scale to the LINE jack. Read approx. 500 ohm in all positions of the LINE switch.

2. Move the TALK MONITOR LINE HOLD switch to the ON HK position; the ohmmeter should read an open circuit.

3. Move this switch to OFF HK 2W + 4W positions and ohmmeter should read approx. 500 ohms.

4. Place the FUNCTION switch to REC & TALK and measure approx. 500 ohms.

5. Remove the ohmmeter from the LINE jack and insert into one of SEND jacks with SEND HOLD switch in the ON position. Meter should indicate 500 ohms. In the OFF position the meter should indicate open circuit. Remove meter.

6. Connect the external oscillator set at 1 kHz, 0dBm to the REC 310 jack and VTVM unloaded to line 309-310 jack. Move the TALK MON switch to the 2W TALK position. Internal meter should read 0. No 1000 Hz tone should be heard in headset, while blowing into headset will cause VTVM level to rise.

7. Move the TALK switch to the MON + 4W TALK position. A 1000 Hz tone should be heard in receiver of headset while blowing into mouthpiece; should cause VTVM level to rise.

8. Load VTVM with 600 ohms. Remove the external oscillator from the REC jack and connect it to the EXT EQUIP jack and VTVM should read 0 dB.

TTS 4CR DIALING PROCEDURE

1. Place all switches in normal position.

2. Switch "TALK, MON LINE HOLD" to ON HK.

3. Plug 52A headset into talk and mon jack.

4. Plug a telephone line 310 into line jack.

5. Place "TALK, MON LINE HOLD" switch to "OFF HK, 2W TALK" Should hear dial tone.

6. Dial 44972, should hear milliwatt gen.

7. Place the LINE switch to REC and the 4CR meter should read the milliwatt level. Return the LINE switch to TALK+EXT.

8. Place the TALK, MON LINE HOLD switch to ON HK. This should discontinue the signal.

9. Place the TALK, MON LINE HOLD switch OFF HK 2W TALK.

10. Dial 723 and then place the TALK, MON LINE HOLD switch to ON HK. A short time later the CALL lamp under the TTS 4CR meter should flash.

11. With the CALL lamp flashing, place the LINE switch to REC. The CALL lamp should discontinue to flash.

12. Place the FUNCTION switch to CAL SEND and it should still be possible to zero the TTS 4CR meter.

13. Return all switches to their normal positions and remove all cords.

TTS 4CR INTERNAL & EXTERNAL DIAL

1. Connect the REC LOOP jack of a TTS 26B to the INT DIAL jack of the TTS 4CR.

2. Calibrate the TTS 26B meter and set the controls as follows:

   a. PULSES PER SEC - 10

   b. RECEIVE - REC-LOOP

   c. METER CIRCUIT - % BREAK THRU METER RELAY

   d. FUNCTION - SEND & REC

3. Dial digit 0 on the TTS 4CR dial and the TTS 26B meter should read between 57% - 63% break.

4. Insert an external dial into the EXT DIAL jack.

5. Repeat steps 1 thru 6 of the TTS 4CR DIALING PROCEDURE using the external dial.

TTS-4CR NOISE TO GROUND

1. Plug two 310 GR cords together and plug one 310 into SEND 310 and the other end into the line 310 jack.
2. Line switch to receive.
3. IMP to bridge.
4. Send level to -5 db, zero the meter.
5. Separate the two GR plugs and connect the tips together.
6. Ground the ring of the send GR to GND terminal.
7. Short the RING and TIP of the line GR.
8. Switch REC INPUT to NOISE TO GND.
9. Switch REC LEVEL to -40 db.
10. Meter should read 0 db ±1.0 db.
11. Disconnect the GR plugs and connect the rings together.
12. Ground the TIP of the SEND GR into the GND terminal.
13. Short the RING and TIP of the line GR.
14. Meter should read 0 db ±1.0 db.
15. Remove all cords; return all switches back to normal.

TTS-4CR TB5 CHECK-OUT

1. Check to see if the orange wire goes from TB5-7 to TB3-14 and the black wire goes from TB5-8 to TB3-8.
2. Switch REC input to EXT VIA T.B. Clip ohmmeter to:

Receive:	Tip	to	TB5	pin:	6	should	read	zero	ohms
"	Ring	"	"	"	5	"	"	"	"
"	Sleeve	"	"	"	4	"	"	"	"
"	Gnd.	"	"	"	3	"	"	"	"

3. Remove ohmmeter; turn set on. Turn all switches to normal. Clip a GR CLIP cord from TB5-1 & 2 to a VTVM. Load with 600 ohms.

   Function switch to CAL SEND; zero 4C meter.

   Function switch to SND & REC & TALK.

   Line switch to SEND. VTVM should read zero. Remove all cords.

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TTS 4C & 4CR POWER SUPPLY CHECKS

1. Remove all cords and place all switches in their normal positions.

2. Connect the 4C power supply to a variable supply capable of at least -70 volts DC.

3. Monitor the -12.5V supply of the 4C while varying the -48V supply from -20V to -70V. The -12.5V should not vary more than ±0.25 volts. Turn off the 4C power switch and remove external supply.

4. Connect 115 VAC to the 4C power supply. Activate the 4C power switch to EXT. Measure -12.5V ±0.25V at the -12.5V output. Turn off the power and remove the AC cord.

TTS 4C ONLY

5. Connect a variable supply set at -18 volts to the battery input terminals on TB-3.

6. Actuate the 4C power switch to BAT and measure -12.5V ±0.25V at the -12.5V output.

7. Switch the METER FUNCTION switch to BAT TEST and adjust the -18V supply until the pointer on the 4C meter reads just at the left hand edge of the green arch. The input supply voltage should be -14.5V to -15.5V. The -12.5V supply should still be -12.5V ±0.3 volts.

TELEPHONE LINE CHECKS (TTS4C ONLY)

1. Place all 4C switches in their normal positions.

2. Actuate the 4C FUNCTION switch to CAL SEND and adjust the send level control for a zero reading on the 4C meter. Return the FUNCTION switch to SND+REC+TALK.

3. Connect a 52A headset to the TALK+MON jacks of the 4C.

4. Patch a 310 R&T cord from the 4C LINE 310 jack (4W-S) to the NORMAL jack on a TTS 4XDR-2.

5. Patch the telephone line to the LINE 310 jack of the TTS 4XDR-2

6. Place the LINE switch on the TTS 4XDR-2 to ON. A dial tone should be heard in the earphone.

7. Dial 4-4972 and a distinct 1 kHz tone should be heard in the earphone.

8. Place the LINE switch to REC and the 4C meter should register an approx. -6 dB reading. Return the LINE switch to TALK+EXT.

9. Switch the TALK, MON, LINE HOLD switch to ON HK and then back to OFF HK, 2W TALK. A dial tone should be heard in the earphone.

10. Dial 723 and place the TALK, MON, LINE HOLD switch to ON HK. The CALL lamp below the 4C meter should flash.

11. With the CALL lamp flashing, actuate the 4C LINE switch to REC. The CALL lamp should discontine to flash.

12. Return the TLAK, MON, LINE HOLD switch to OFF HK, 2W TALK. A dial tone should be heard in the earphone. Remove all cords from the 4C.

13. Actuate the FUNCTION switch to CAL SEND. The 4C meter should still read zero. Return all switches to their normal positions.

FINAL CALIBRATION (TTS 4C & 4CR)

1. Install all dust covers before starting final calibration.

2. Set REC module switches as follows:

METER FUNCTION	RSS
REC LEVEL	0 (CAL)
REC IMP	600
REC LINE	DISC
TRANSF	OUT
NETWORK	FLAT (C-MSG)
IMP	BRDG

3. All line section switches to their center positions.

4. Set the SEND module switches as follows:

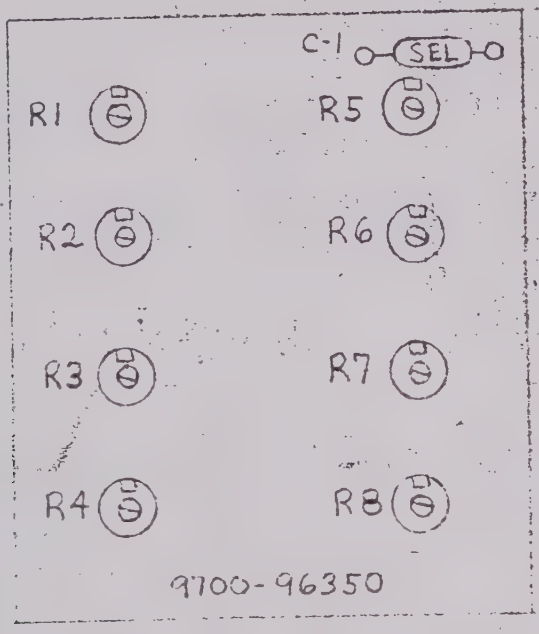
FREQ RANGE	X10
FREQ	FIXED
FIXED FREQ HZ	100
SEND IMP	600
SEND LEVEL	0 (CAL)

5. Connect from the R&T terminals of the 4C SEND module to a 400 FL terminated with 600 ohms. Also patch from the SEND terminals to the 4C receive module R&T terminals with the RING connected to GND.

6. With the 4C laying in a horizontal position, recheck the 4C meter for an absolute zero reading in all positions of the METER FUNCTION switch and readjust if necessary.

7. Glyptol all pots and glue in all transistors.

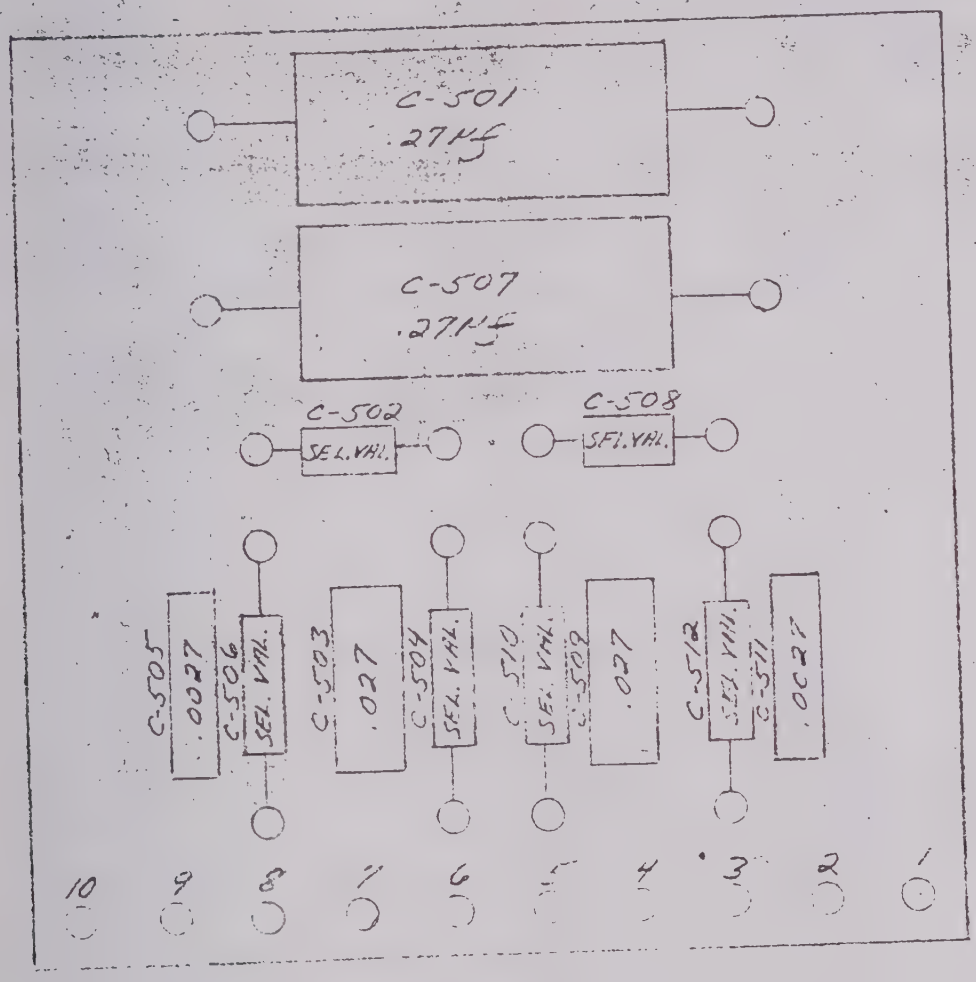
FIG 1



R1, R5 = 1MEG
R2, R6 = 50K
R3, R7 = 20K
R4, R8 = 2K

ISSUE	DATE	APPROVED	REMARKS	NORTHEAST ELECTRONICS CORPORATION CONCORD, N.H.	
				DRAWING NO. 0004-30-401	DATE
				SCALE	DRAWN BY
				JOB NO.	ENGR.

FIG 2



CAPACITORS

C-502, C-508
C-506, C-512
C-504, C-510

MAX. VALUE

.01 MF
120 MMF
.0015 MF

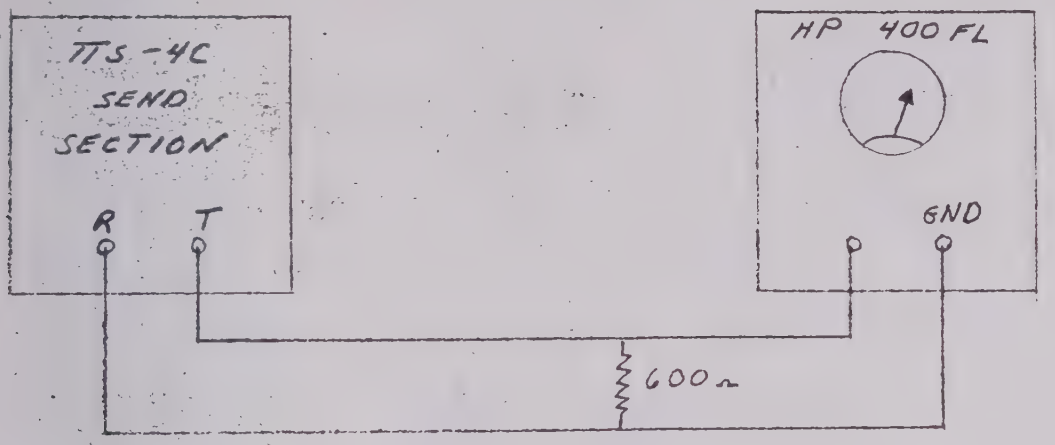
ISSUE	DATE	APPROVED	REMARKS

NORTHEAST ELECTRONICS CORPORATION
CONCORD, N.H.

DRAWING NO. 0004-30-401 | DATE

SCALE | DRAWN BY

JOB NO. | ENGR.



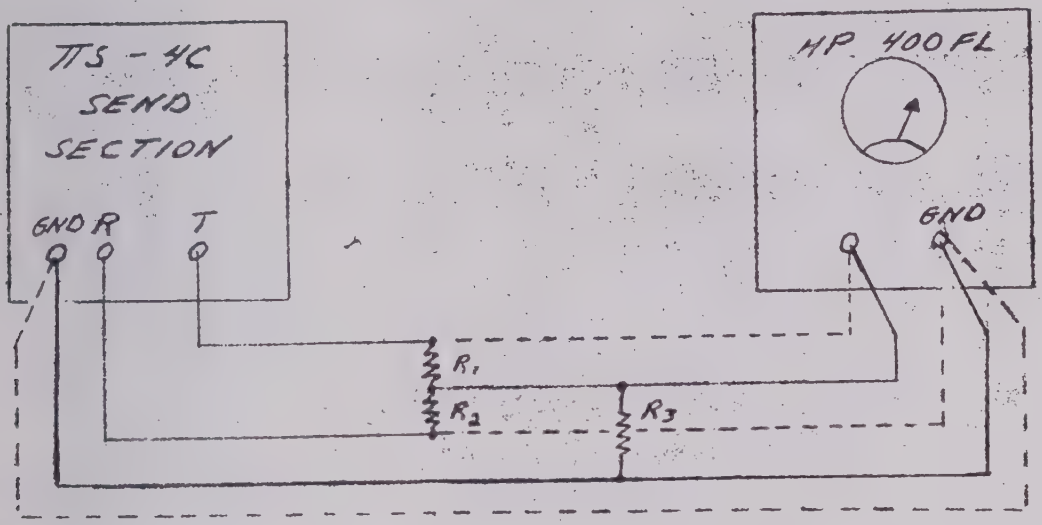
TTS-4C SET UP

FREQ RANGE	X10
FREQ	VAR
SEND LEVEL	0 (CAL)
LEVEL VERNIER	ADJUST FOR 0dB ON THE 400 FL
IMP	600Ω

ATTENUATOR TRACKING

ISSUE	DATE	APPROVED	REMARKS	NORTHEAST ELECTRONICS CORPORATION CONCORD, N.H.	
				DRAWING NO. 0004-30-401	DATE
				SCALE	DRAWN BY
				JOB NO.	ENGR.

OUTPUT BALANCE



R_1, R_2 = 67.5Ω FOR THE 135Ω LOAD
450Ω FOR THE 900Ω LOAD

R_3 = 150Ω

THE BROKEN LINES INDICATE THE SET UP FOR REFERENCE LEVEL MEASUREMENT

THE SOLID LINES INDICATE THE SET UP FOR BALANCE MEASUREMENT

BALANCE IN dB IS THE TOTAL NUMBER OF dB BELOW REFERENCE LEVEL AS MEASURED WITH THE HP 400 FL

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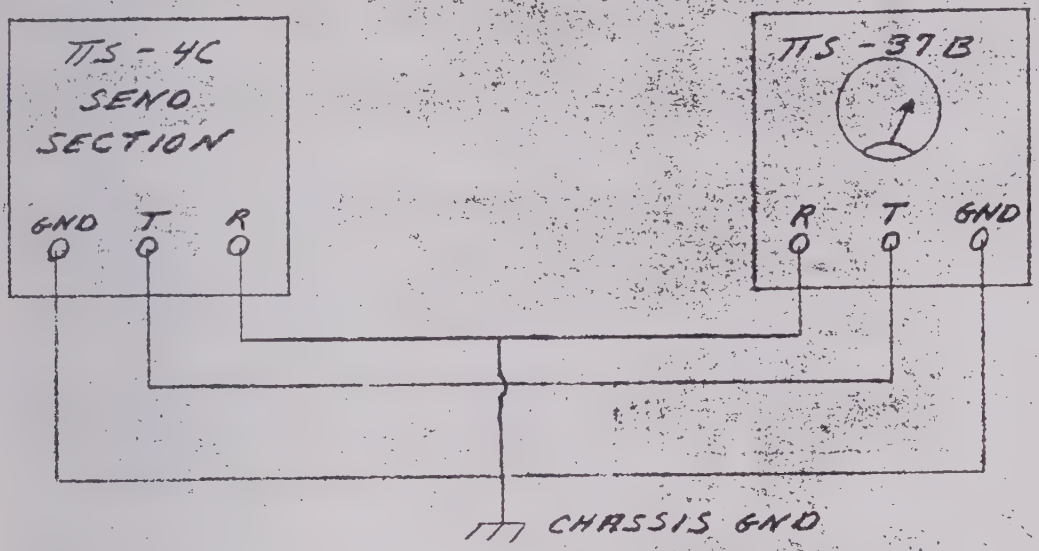
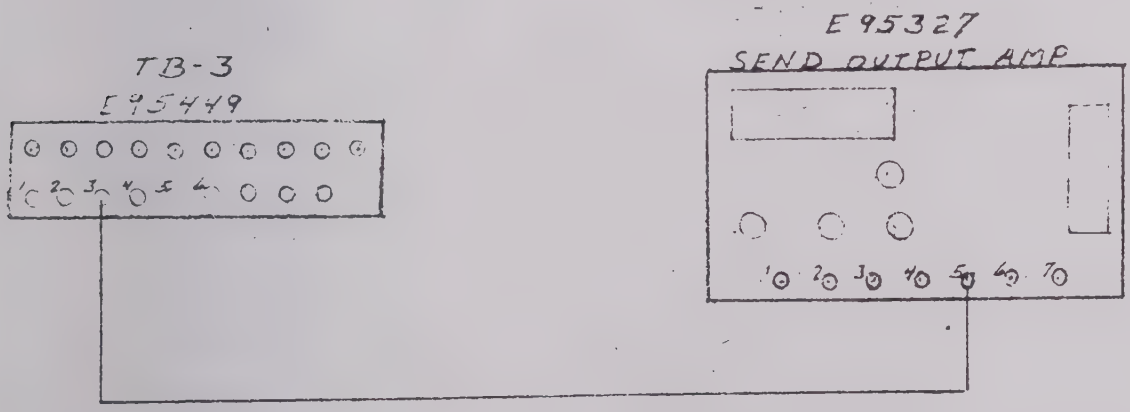
FIG 5

SIGNAL TO NOISE



NOISE SHOULD BE ≥ 90 dB BELOW THE OUTPUT LEVEL OF THE TTS-4C SIGNAL



NOTE: DURING SIGNAL TO NOISE TEST, A CLIP LEAD MUST BE CONNECTED AS SHOWN ABOVE.

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FIG 6

TTS-4C SPECIAL LOADS

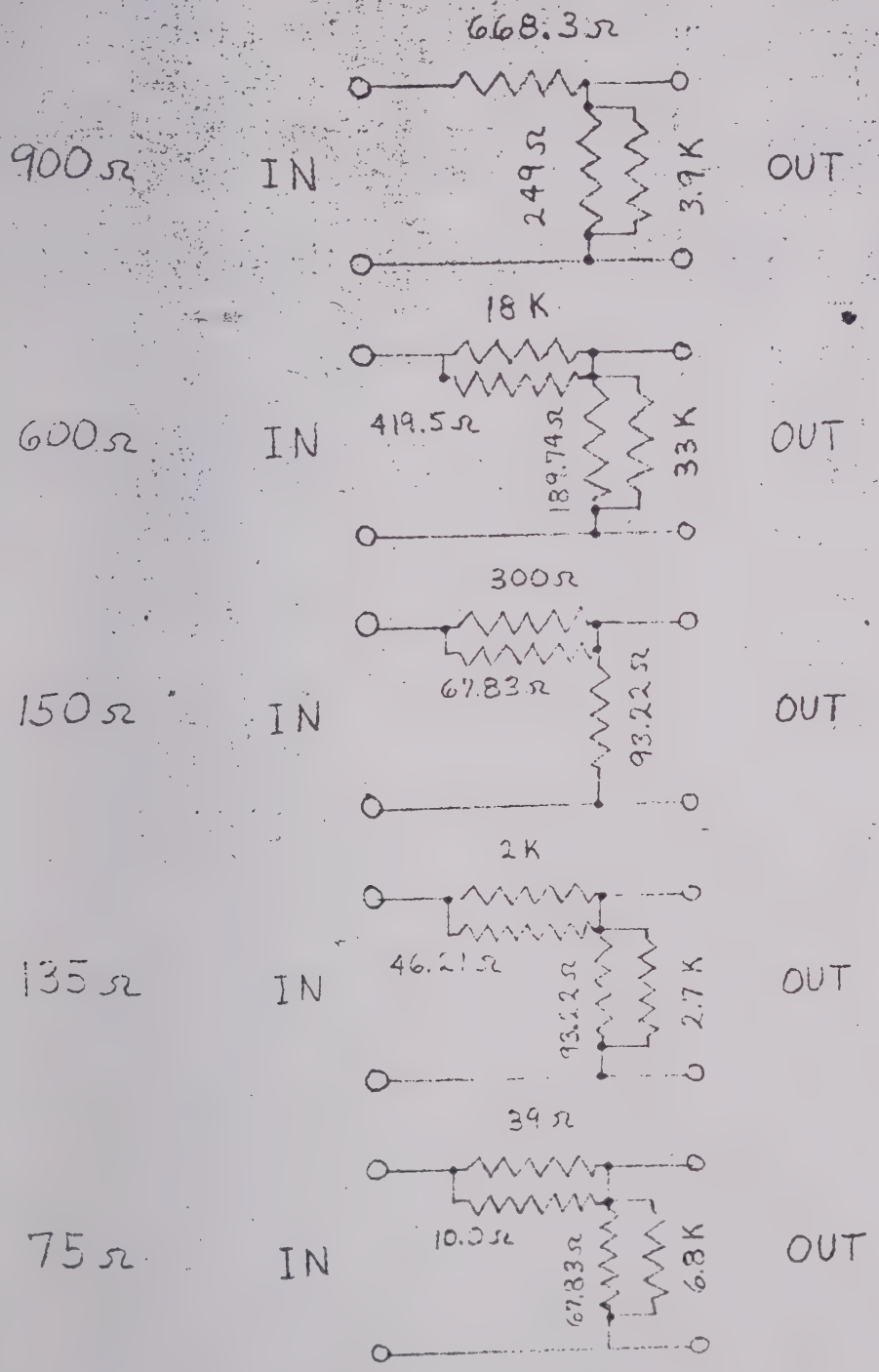

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FIG 7

KEELINE SECTION - CALIBRATION

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FIG. 8

X-RAY DETECTOR CALIBRATION

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